

NEW SPECIES OF *ELEUTHERODACTYLUS* FROM THE CORDILLERA OCCIDENTAL OF WESTERN COLOMBIA WITH A SYNOPSIS OF THE DISTRIBUTIONS OF SPECIES IN WESTERN COLOMBIA

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Resumen

Lynch, J. D. New species of *Eleutherodactylus* from the Cordillera Occidental of western Colombia with a synopsis of the distributions of species in western Colombia. Rev. Acad. Colomb. Cienc. 22 (82): 117-148. 1998. ISBN 0370-3908.

Se describen nueve especies más del género *Eleutherodactylus* de la Cordillera Occidental. Una de estas se encuentra en la transición entre los bosques de tierras bajas y bosques nublados en el noreste Colombiano, otra se encuentra en bosques nublados del occidente del Antioquia, otra en los bosques nublados entre Cali y Popayán, y las otras en la Serranía de los Paraguas. Se da un sumario de las distribuciones de las 102 especies de *Eleutherodactylus* que se encuentran en la occidente de Colombia, con base en datos de una serie de perfiles.

Palabras claves: Amphibia, Leptodactylidae, biogeografía, taxonomía

Abstract

Nine additional species of *Eleutherodactylus* are described from the Cordillera Occidental. One of these occurs in the transition between lowland forests and cloud forests in northwestern Colombia, one is found in cloud forests of western Antioquia, another is found in cloud forests between Cali and Popayán, and the remainder are species found on the Serranía de los Paraguas. The distributions of the 102 species of *Eleutherodactylus* found in western Colombia are summarized using data from a series of transects.

Key words: Amphibia, Leptodactylidae, biogeography, taxonomy

Introducción

Western Colombia (the Pacific lowlands and the western slopes of the Andes above them) is a region of unparalleled biological diversity and that diversity is reflected as well in the frogs of the genus *Eleutherodactylus* (Figs. 1-12). With the new species reported here, that fauna consists of 25 species in the lowlands (and probably with additional collecting, *E. ornatissimus*, as well) – *E. achatinus*, *anomalus*, *biporcatus*, *busoniformis*, *caprifer*, *caryophyllaceus*, *chalceus*, *fitzingeri*, *gaigei*, *gularis*, *hybotragus*, *labiosus*, *latidiscus*, *longirostris*, *moro*, *parvillus*, *raniformis*, *ridens*, *rosadoi*, *roseus*, *subsigillatus*, *taeniatus*, *zygodactylus*, and two apparently undescribed species of the *diastema* group – and 74 species from the western Andean flanks (and probably with additional collecting, *E. calcarulatus* and *E. necerus* as well, known from just across the border in Ecuador). It is unlikely that these 102 species are the only species of the genus in western Colombia because some areas remain poorly inventoried and some groups appear to be composed of very locally distributed species.

The Cordillera Occidental is one of the biogeographically richest areas of Colombia in terms of its fauna of eleutherodactyline frogs (Lynch *et al.*, 1997) but there remain several undescribed taxa in the collections gathered by personnel of the ICN between 1980 and 1997. Most of the undescribed frogs come from the Serranía de los Paraguas (on the frontier between departamentos Chocó and Valle del Cauca), an area of very considerable diversity for frogs of the genus *Eleutherodactylus*. Ruiz-C. *et al.* (1997) published a table illustrating the altitudinal and latitudinal distributions of 33 species on the northern part of the Cordillera Occidental. That table is rendered obsolete by the descriptions of additional species from the Serranía de los Paraguas and one found widely distributed in the lower limits of the cloud forests of the northern part of the Cordillera Occidental (Risaralda to Antioquia).

Materials and methods

Methods and terminology follow Lynch & Duellman (1997). Specimens were measured using dial calipers to the nearest 0.1 mm using a dissecting microscope. Means are reported as ± 1 standard error of the mean. The following abbreviations are used throughout the text : SVL (snout-vent length), IOD (interorbital distance), E-N (eye to nostril distance), HW (head width).

Accounts of species

For much of the past 15 yr, a small frog described by Lynch (1981), *E. brevifrons*, has been a common cloud forest frog in virtually all of the transects my colleagues and I have made of the Cordillera Occidental north of the Río Páitia. In fact, we have tended to overlook variation in this species because we knew that it was pattern polymorphic. However, in 1995, during study of material in the Museo de Historia Natural of the Universidad del Valle, I noted that one pattern variant appeared to be a distinct species. In collecting on the Serranía de los Paraguas in 1997, it was apparent that this variant was a species distinct from the smaller *E. brevifrons*. Subsequent study of all preserved material tentatively assigned to *E. brevifrons* in the ICN collection revealed that three species had been bottled as that taxon, including one found in northern Valle del Cauca and adjacent Risaralda and a second found only in western Antioquia. Each is sympatric with the smaller *E. brevifrons*. Because collectors (including me) have confused these two species, as color pattern morphs, with *E. brevifrons*, it is appropriate to review variation in that species prior to the descriptions of the new taxa.

Eleutherodactylus brevifrons Lynch (Fig. 13)

At the type-locality (Cerro San Antonio, Mpio. de Cali, Valle del Cauca) and nearby sites in western Valle del Cauca, *E. brevifrons* is the smallest species of the genus (males 14.3-18.0 mm, females 19.8-22.3 mm SVL). It is a species that calls early in the evening, usually in exposed sites along the forest edge or in pastures and then ceases to call by about 2000 h. The call is a sharp “peep”. During the day, individuals seek retreats in bromeliads.

Although only briefly mentioned by Lynch (1981:11), *E. brevifrons* is pattern polymorphic (Fig. 13). Pattern data were taken for 169 individuals throughout its known distribution. Most individuals (80.5%, 136/169) have a mottled color but there are also individuals having a dorsocconcicolor (6.5%, 11/169) pattern (a pale dorsum, with no darker markings, edged with black or dark brown, a central raphe (9.5%, 16/169) morph (pale dorsum, edged with dark brown/black, and a broad vertebral dark stripe extending to the sacrum or just beyond), and a lineate (3 individuals) morph (dorsum not pale, bearing vertebral and paravertebral stripes extending from snout to above vent). Two individuals have a pale blotch on the head (headcap morph) bordered by dark pigment; otherwise, they are mottled and one individual has pale dorsolateral stripes superimposed on a mottled pattern. Addi-



Figure 1. *Eleutherodactylus angustilineatus* sp. nov., ICN 39599, female, 24.8 mm SVL.



Figure 2. *Eleutherodactylus calcaratus*, ICN 36940, female 27.8 mm SVL.



Figure 3. *Eleutherodactylus chrysops*, JDL 21155, male 58.4 mm SVL.



Figure 4. *Eleutherodactylus deinops*, ICN 36917, female, 49.7 mm SVL.



Figure 5. *Eleutherodactylus juanchoi*, JDL 20420, male, 21.0 mm SVL.



Figure 6. *Eleutherodactylus kelephus* sp. nov., ICN 39670, young female, 27.1 mm SVL.



Figure 7. *Eleutherodactylus myops* sp. nov., ICN 39685, female, 16.7 mm SVL.



Figure 8. *Eleutherodactylus phalarus* sp. nov., holotype, ICN 39678, 19.1 mm SVL.



Figure 9. *Eleutherodactylus quantus* sp. nov., ICN 29315, male, 13.0 mm SVL.



Figure 10. *Eleutherodactylus ptochus* sp. nov., holotype, ICN 39780, female, 23.5 mm SVL.



Figure 11. *Eleutherodactylus sanguineus* sp. nov., ICN 19335, female, 29.1 mm SVL. Photograph courtesy of P. M. Ruiz.



Figure 12. *Eleutherodactylus silverstonei*, JDL 21073, juvenile female, 26.4 mm SVL.

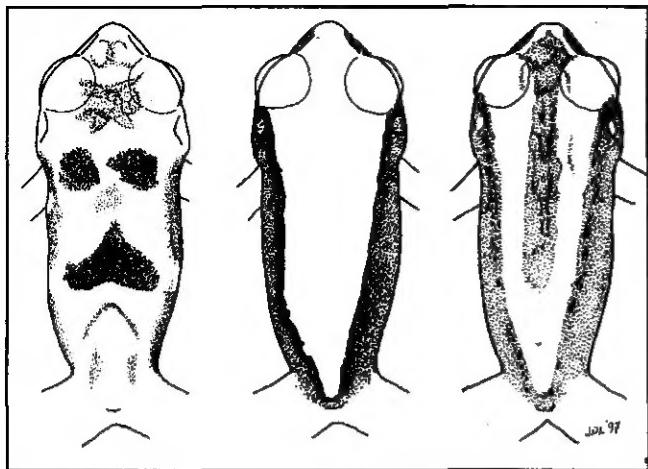


Figure 13. Color pattern polymorphism in *Eleutherodactylus brevifrons*.
(A) Mottled, ICN JDL 20484; (B) Dorsococoncolor, ICN JDL 20479; (C)
Central Raphe, ICN 16782.

tionally, seven mottled individuals have a pale blotch on the upper lip (subcanthal spot) and two others have the entire snout pale (otherwise mottled) and cannot be scored for a subcanthal spot. The subcanthal spot initially appeared to be distinctive but the degree of paleness seems to vary continuously rather than being a discrete variant. The pale dorsolateral stripe morph also has pale canthal spots. The headcap morph is known only from the Murri transect and the **mottled with pale dorsolateral stripes** is known only from Munchique but each is a rare morph. Using the overall frequencies of morphs, I calculated an expected value for each morph for each population. The observed values (Table 1) do not depart from expected values, denying any geographic variation in morph frequencies, contrary to the case for *E. erythropleura* (Lynch, 1993), another cloud forest species distributed more or less coincidentally with *E. brevifrons*. Aside from Munchique, adults are the same sizes in all transects (Table 2). The sizes reported by Lynch (1981) for the species are correct but he failed to note that all of the larger frogs came from the Munchique transect.

When my colleagues and I first collected the Serranía de los Paraguas, we heard *E. brevifrons* calling and collected that species only sparingly. The presence of a distinctive "color morph" did not register and the sample collected was inadequate to reveal that this is a larger frog. Subsequent study of material reveals that the species is monomorphic and can be characterized by the presence of a thin pale dorsolateral stripe edged below by dark pigment.

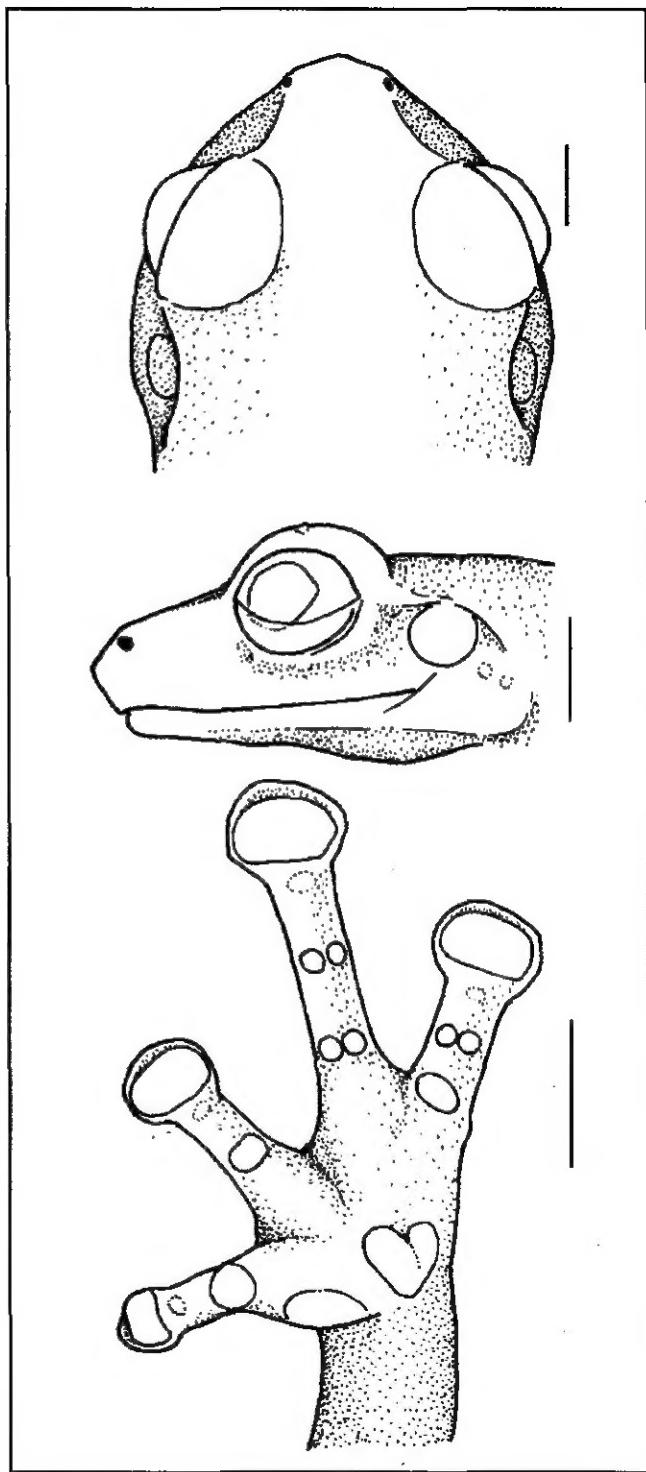


Figure 14. Dorsal (ICN 39599) and lateral views of head (ICN 31301),
palmar view of hand (ICN 39599) of *Eleutherodactylus angustilineatus*
sp. nov. Scales equal 2 mm.

Table 1. Color pattern morphs in *Eleutherodactylus brevifrons* over its geographic distribution
(values reported are expected number/observed number of each morph).

Location	N	mottled	dorsal concolor	raphe	lineate	head cap	DL stripes
Cauca	15	12.1/12	0.9/2				/1
Valle del Cauca	53	42.7/43	3.3/5	5.0/4	/1		
Paraguas	26	20.9/23	1.7/1	2.5/2			
Risaralda	6	4.8/5	0.4/0	0.6/1			
Urrao	15	12.1/12	0.9/1	1.4/2			
Murí	54	43.5/41	3.4/2	5.1/7	/2	/2	

Holotype. ICN 39598 (JDL 21228), an adult male, one of a series collected by Taran Grant and John D. Lynch 25 July 1997.

Type-locality. COLOMBIA, Departamento Valle del Cauca, Municipio El Cairo, vereda Las Amarillas, sitio El Boquerón, 19.85 km del cementerio de El Cairo, 2140-2150 m.s.n.m.

Paratotypes. ICN 39599 (female), 39600-11 (males), collected with holotype, ICN 29277-82, 29284-86, collected 24 June 1991 by J. D. Lynch, Jorge Restrepo, Pedro Ruiz, and Ricardo Sánchez, UVC 12957, collected 1-2 April 1996 by T. Grant.

Paratypes. Colombia, Depto. Chocó: límite con Valle del Cauca, 20-24 km del cementerio El Cairo por la carretera a El Boquerón, 1900-2250 m (ICN 29247-51, 29254-57, 29259, 29261), cols. JDL, J. Restrepo, PM Ruiz, & R. Sánchez, 22 June 1991, (ICN 39614-17), col-

lected 20 July 1995 by Roberto Bello and Erik Wild, (UVC 10113), col. M. S. Alberico & J. Restrepo, 2-3 Marzo 1989; 5.7 km W El Boquerón, 1900 m (ICN 29287), col. JDL 25 June 1991; municipio San José del Palmar, paso Galápagos, 1800 m (UVC 7666), col. J. H. Restrepo, 15 Oct. 1984, 12.0-12.6 km by road W San José del Palmar, 1850-1860 m (ICN 19156, 19159), col. JDL, PMR, RS, 8 June 1988; 14.8-15.4 km by road W San José del Palmar, sitio "Los Galápagos", 1980-2000 m (ICN 18264-265, 19163-69), cols. A. Cadena, JDL, PMR, RS, 9 June 1988; Alto de los Galápagos, ca 2000 m (UVC 8083-84, 8440-48, 9306-07, 9403, ICN 14104), cols. J. H. Restrepo y otros, 16 Mayo 1985-3 Agosto 1986. Depto. Risaralda : municipio Apia: vereda La Cumbre, quebrada Risaralda, 2230-2300 m (ICN 31296-302), cols. M. C. Ardila, G. Bernal, J. Murillo, 16 May 1992; municipio Mistrató: Km. 1, carr. Mistrató-San Antonio del Chamí 1810-1880 m (ICN 30301-02), col. P. M. Ruiz et al, 4 April 1992, Km. 10, 1720 m (ICN 30299),

Table 2. Body sizes in six populations of *Eleutherodactylus brevifrons*. Values given are range in mm (mean + 1 S.E.) N.

	Males	Females
Cauca	16.1-19.5 (18.3 + 0.2) 13	
Valle del Cauca	14.3-18.0 (16.2 + 0.9) 63	19.8-22.3 (21.2) 3
Paraguas	16.0-18.0 (16.9 + 0.1) 25	21.8
Risaralda	16.3-16.6 (16.4) 2	22.1-24.9 (23.8) 3
Urrao	15.8-17.3 (16.4 + 0.1) 12	20.5-22.3 (21.4) 2
Murí	15.2-18.6 (17.0 + 0.1) 40	20.8-22.8 (21.8 + 0.3) 8

col. P. M. Ruiz, 30 March 1992, Km. 11, Qda. Mampay, 1760-1830 m (ICN 30298), col. P. M. Ruiz, 2 April 1992, Km. 13, 1760-1790 m (ICN 30300), col. P. M. Ruiz, 29 March 1992; vereda Mampay, Qda. Sutu, 1700-1940 m (ICN 30469), col. M. C. Ardila, 4 April 1992; municipio Pueblorico, via La Selva-la repetidora, desvio km 7 carr. Pueblorico-Santa Cecilia, Km. 21-22, 1700-1820 m (ICN 30554-60), cols. M. C. Ardila & S. Roa, 22 Sept. 1991; vereda Tatamá, río Tatamá, 1800 m (ICN 28092-95), col. M. C. Ardila, 12 April 1991. Depto. **Valle del Cauca**, municipio El Cairo, El Boquerón, Cerro El Inglés, 2200-2500 m (UVC 9097, 9110), col. J. Restrepo, 27-28 Feb. 1986, 2400 m (UVC 9027, 9031-32) cols. P. Silverstone et al., 27 Dic. 1986-6 Ene. 1987; "Los Galápagos", 20.2 km by road NW La Carbonera, 2100 m (ICN 29288-93), cols. JDL, J. Restrepo, PMR, R. Sánchez, 28 June 1991, ICN 39612, col. E. Wild, 19 July 1995.

Etymology. Latin, *angustus* (narrow) + *lineatus* (of a line), in reference to the narrow white dorsolateral lines in the color pattern.

Diagnosis. (1) Skin of dorsum smooth, that of venter areolate; no dorsolateral folds; (2) tympanum round, directed posterodorsolaterally, its length 1/3-2/5 eye length; (3) snout subacuminate in dorsal view, pointed in lateral profile; canthus rostralis concave; (4) upper eyelid lacking pungent tubercles, slightly narrower than IOD; no cranial crests; (5) vomerine odontophores low, oblique, widely separated; (6) males with subgular vocal sac, white nonspinous nuptial pads; (7) first finger shorter than second; all fingers bearing round discs and pads, largest on outer fingers; (8) slight lateral keels on fingers; (9) no ulnar tubercles; (10) no tubercles on heel or tarsus; (11) two metatarsal tubercles, inner oval, ca 4 times size of round outer; supernumerary plantar tubercles indistinct; (12) toes bearing narrow lateral fringes, no webbing; toe discs and pads round, smaller than those of fingers; fifth toe very long; (13) yellow-tan above with thin white dorsolateral stripes bordered below by black; (14) adults small, males 15.8-20.4 ($\bar{x}=18.6 \pm 0.1$, N = 61) mm, females 20.8-24.8 ($\bar{x}=22.6 \pm 0.2$, N = 18) mm SVL.

Eleutherodactylus angustilineatus is most similar to *E. baiotis*, *E. boulengeri*, *E. brevifrons*, *E. dorsopictus*, *E. eremitus*, and *E. tayrona* but differs from each in lacking tubercles on the upper eyelid and heel. Furthermore, *E. brevifrons*, *E. dorsopictus*, and *E. eremitus* have tubercles on the tarsus. It is sympatric with *E. brevifrons*, a smaller frog having a shorter snout. The color pattern of *E. angustilineatus* is likewise distinctive although it initially appeared to be simply another color morph and led

to confusion of the two species in the field until explicit searches were carried out.

Description (proportions based on 25 males and 17 females). Head broader than body, longer than wide; HW 35.0-39.2 ($\bar{x}=37.0 \pm 0.2$) % SVL in males, 36.6 - 41.9 ($\bar{x}=38.5 \pm 0.4$) % in females, posterior part of head weakly flared in females; snout subacuminate in dorsal view (papilla at tip), acutely rounded or subprotruding in lateral view (Fig. 14); E-N 76.9-92.3 ($\bar{x}=83.2 \pm 1.1$) % eye length in males, 77.4-96.9 ($\bar{x}=88.4 \pm 1.4$) % in females; nostrils weakly protuberant, directed dorsolaterally; canthus rostralis prominent, slightly concave; loreal region concave sloping abruptly to lips; lips not flared in region of snout; upper eyelid lacking tubercles, its width 66.7-100.0 ($\bar{x}=84.5 \pm 2.6$) % IOD in males, 73.1-119.0 ($\bar{x}=84.8 \pm 2.8$) % in females; interorbital space flat; supratympanic fold ill-defined, obscuring upper edge of tympanum; tympanum round, its length 25.0-41.7 ($\bar{x}=33.6 \pm 1.0$) % eye length in males, 31.2-44.4 ($\bar{x}=37.7 \pm 0.9$) % in females, directed dorsolaterally and posterolaterally (obviously not vertical), separated from eye by distance equal its own diameter; two small postorbital tubercles; choanae small, oval, well medial of palatal shelf of maxillary arch; vomerine odontophores median and posterior to choanae, low, slanted, widely separated, small (ca 1/3 size of a choana), each bearing 2-4 teeth in a slanted row; tongue longer than wide, its posterior border notched, posterior $\frac{1}{2}$ not adherent to floor of mouth; vocal slits long, lateral to tongue; males with large subgular vocal sac.

Skin of dorsum smooth, lacking folds, that of venter areolate; no perianal tubercles; discoidal folds well anteriad to groin; no ulnar tubercles; palmar tubercle bifid, much larger than oval thenar; small indistinct supernumerary palmar tubercles; subarticular tubercles low, bifid on fingers III-IV, round on fingers I-II; fingers bearing narrow lateral keels; discs and pads round, expanded; those of thumb least expanded (Fig. 14); first finger shorter than second; males with white nuptial pads atop thumbs.

Heels and tarsus lacking tubercles or folds; inner metatarsal tubercle twice as long as wide, about 4 times size of round outer; low supernumerary plantar tubercles present; subarticular tubercles round (inner toes) to broader than long (outer toes); toes bearing narrow lateral fringes, expanded, round discs (smaller than those of outer fingers); tip of toe III reaches to base of penultimate subarticular tubercle of IV, that of toe V reaches to middle of distal subarticular tubercle of toe IV; heels barely overlapping when flexed hindlimbs held

perpendicular to sagittal plane; shank 48.4-55.4 ($\bar{x} = 52.0 \pm 0.4$) % SVL in males, 48.9-56.2 ($\bar{x} = 52.0 \pm 5.4$) % in females.

Dorsal surfaces tan to pale brown with none or few black or brown flecks; dorsal pattern bordered by a thin white dorsolateral line from eyelid to above groin; this stripe bordered below by dark brown or black (usually most intense anteriorly); canthal stripe brown; no labial bars evident; forearm, shank, and sometimes tarsus bearing brown flecks arranged as narrow oblique bars; concealed surfaces of limbs, undersides of limbs, and flanks cream; throat and venter white.

In life, *E. angustilineatus* is yellow or yellowish-green above with some brown flecking dorsally (occasional individuals are nearly red above); dorsolateral stripe yellow bordered below by brown to nearly black; vocal sac pale yellow; parietal peritoneum metallic white; upper eyelid pale green; iris reddish-brown or copper with black reticulation.

Measurements of holotype in mm. SVL 19.8, shank 10.1, HW 7.2, head length 7.3, chord of head length 8.0, upper eyelid width 2.2, IOD 2.3, tympanum length 0.9, eye length 2.8, E-N 2.2.

Natural history. In reviewing fieldnotes for 1991, 1995, and 1997, it is apparent that *E. angustilineatus* is spatially separated from *E. brevifrons*, in part by habitat selection. *Eleutherodactylus brevifrons* is most frequently found in disturbed situations (edges of pastures, etc) whereas *E. angustilineatus* more often than not occurs within the forest. The two species are macrosympatric but not microsympatric. During the day, *E. angustilineatus* was found in bromeliads growing on the cliffs at El Boquerón.

Four amplexant pairs were found, providing a biological check on the mean sizes given in the diagnosis. These sizes of these pairs are: (male followed by female) ICN 29247-48, 17.8 and 23.2 mm SVL; ICN 29249-50, 18.2 and 22.0 mm SVL; ICN 29277-78, 18.2 and 23.1 mm SVL; and ICN 39598-99, 19.8 and 24.8 mm SVL. The call, repeated late into the night (unlike *E. brevifrons*), is a single sharp "tink". Juvenile males (no vocal slits) are 9.8-15.5 mm SVL and juvenile females (thin oviducts, only small eggs) are 12.6-20.8 mm SVL. Based on limited data, the species appears to be aseasonal in reproduction.

In July 1997, El Boquerón was an unusual environment, presumably because of the sharp dry season in-

duced by El Niño. Normally, El Boquerón is fog-shrouded with nearly continual rain. During our visit in July 1997, it did not rain at all in four days and the nights were clear. During the day, the area was bathed in strong sunlight. Within these cloud forests, the epiphytic mosses were dry to the touch. Such a sharp dry season is unusual yet *E. angustilineatus* was reproducing unlike most other species of *Eleutherodactylus* found there. Occasional calls were heard for *E. erythropleura*, *E. w-nigrum*, and *Gastrotheca antomia*; otherwise the forests were silent. Most impressive was the absence of reproductive activity by centrolenids.

Referred material (juveniles and poorly preserved specimens). Depto. Chocó: límite con Valle del Cauca, 20-24 km del cementerio El Cairo por la carretera a El Boquerón, 1900-2250 m (ICN 29252-53, 29258, 29260, 29262-63); municipio San José del Palmar, Alto de Galápagos, 1800 m (UVC 7664-65, 7667), Cerro Torrá, vert. noreste, 1800-1940 m (UVC 6729), 12.0-12.6 km by road W San José del Palmar, 1850-1860 m (ICN 19160-62). Depto. Risaralda: municipio Apia: vereda La Cumbre, quebrada Risaralda, 2230-2300 m (ICN 31303-04); Municipio Pueblorico, via La Selva-la repetidora, desvio km 7 carr. Pueblorico-Santa Cecilia, Km. 21-22, 1700-1820 m (ICN 30561-66); vereda Tatamá, río Tatamá, 1800 m (ICN 28096). Depto. Valle del Cauca, municipio El Cairo, Cerro El Inglés, 2200 m (UVC 10159-61), El Boquerón, 1880-2250 m (UVC 9146-47, 10734, 12676), "Los Galápagos", 20.2 km by road NW La Carbonera, 2000 m (UVC 8026, 8039-57, 8113-14, 9308-09, 9359, 9404-05, 9552, 9554-55), 2100 m (ICN 39613).

Eleutherodactylus baiotis sp. nov. (Fig. 15)

Holotype. ICNMHN 19170, adult male, one of a series collected 25 May 1988 by John D. Lynch, Pedro M. Ruiz, and Ricardo Sánchez.

Type-locality. COLOMBIA, Departamento de Antioquia, Municipio de Urrao, Parque Natural Nacional Las Orquídeas, vereda río Calles, Quebrada Las Canoas, 1780-1870 m.s.n.m.

Paratotypes. ICNMHN 19173 (female), 19174, 19176 (males), collected with holotype.

Etymology. Greek, *baios* (small) + *otis* (ear), in reference to the small tympani.

Diagnosis. (1) Skin of dorsum finely granular, bearing dorsolateral folds from eye to above groin, that of venter areolate; (2) tympanum prominent, small, ca 1/3 eye length; (3) snout acuminate in dorsal view, protrud-

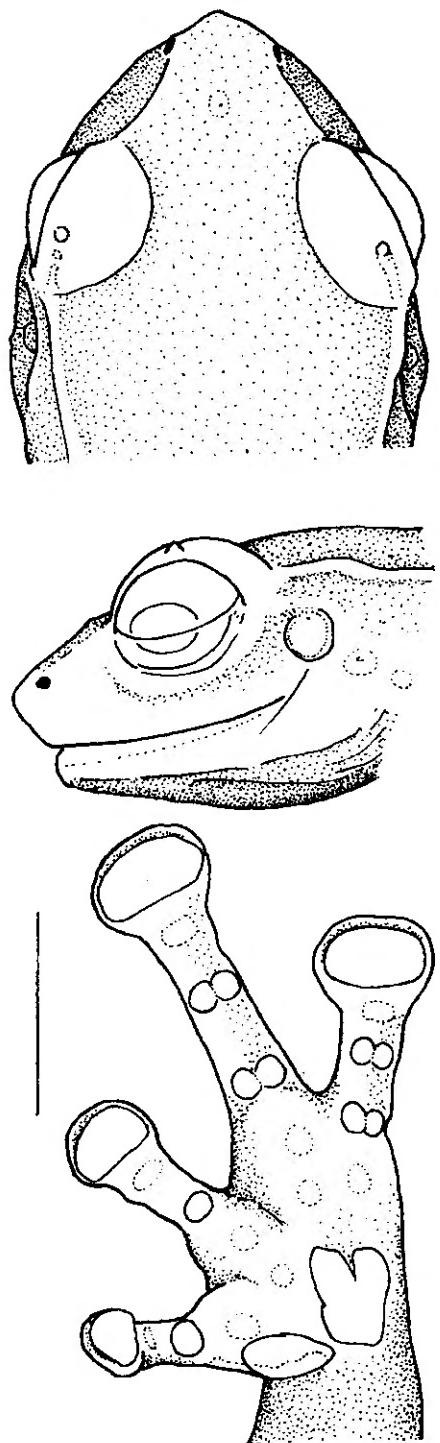


Figure 15. Dorsal and lateral views of head (ICN 19174), palmar view of hand (ICN 19176) of *Eleutherodactylus baiotis* sp. nov.

Scales equal 2 mm.

ing in lateral profile; canthus rostralis sharp; (4) upper eyelid bearing conical tubercle, much narrower than IOD; no cranial crests; (5) vomerine odontophores small, low, oblique; (6) males with vocal slits and nuptial pads; (7) first finger shorter than second; all fingers with large round, disks; (8) fingers bearing lateral fringes; (9) ulnar tubercles subconical; (10) heel and outer edge of tarsus bearing subconical tubercles; (11) two metatarsal tubercles, inner oval, ca 3 times size subconical outer; supernumerary plantar tubercles nonconical; (12) toes bearing lateral fringes, no webbing, large round disks (as large as those of fingers); fifth toe very long; (13) brown above with no pattern; dorsolateral stripe cream, edged below by dark brown band; no labial bars or limb bars; venter cream with black spots; colorless patch in groin; (14) adults small, three males 18.1–18.5 mm, one adult female 21.5 mm SVL.

In coloration, *E. baiotis* resembles *E. angustilineatus* but the former has eyelid, heel, and tarsal tubercles. *Eleutherodactylus baiotis* differs from all other species of "bromeliad" *Eleutherodactylus* because it has dorsolateral folds. Unlike *E. angustilineatus*, *E. brevifrons*, and *E. dorsopictus*, it has a small tympanum. The bifid subarticular tubercles are like those of *E. angustilineatus* and *E. dorsopictus* but unlike the subarticular tubercles of *E. boulengeri*, *E. brevifrons*, *E. eremitus*, or *E. tayrona*.

Description. Head broader than body in males, as broad as body in one female, longer than wide; HW 35.7–36.5 % SVL in males, 37.2 % in one female; snout acuminate in dorsal view with papilla at tip, protruding in lateral profile (Fig. 4); nostrils protuberant, directed laterally; canthus rostralis sharp, straight; loreal region concave, sloping abruptly to lips; lips not flared; conical tubercle on upper eyelid; upper eyelid width 71.4–81.0 % IOD in males, 55.6 % in one female; interorbital space flat; supratympanic fold concealing uppermost edge of tympanum; tympanum oriented vertically, round, its length 29.2–32.0 % eye length in males, 32.1 % in one female, separated from eye by distance equal tympanum length; two nonconical postrostral tubercles; choanae round to oval, moderately large, well medial of palatal shelf of maxillary arch; vomerine odontophores median and posterior to choanae, small, slanted, separated medially by twice width of an odontophore; each bearing 2–4 teeth in slanted row, each about 1/3 size of a choana; tongue longer than broad, its posterior border bearing shallow indentation, posterior 1/3 not adherent to floor of mouth; long vocal slits lateral to tongue; vocal sac subgular.

Skin of dorsum shagreen, bearing low areolations with low dorsolateral folds extending from eye to above groin; flanks with more coarse tubercles; venter areolate; discoidal folds well anteriad to groin; pair of flat subanal tubercles; no anal sheath; 2-3 nonconical but large ulnar tubercles; palmar tubercle bifid, much larger than oval thenar; numerous low supernumerary palmar tubercles; subarticular tubercles of fingers I-II round, those of III-IV bifid; fingers bearing fleshy lateral fringes (including one along outer edge of palm); discs large, round, largest on outer fingers (Fig. 15); first finger shorter than second; large white nuptial pad atop thumb of male.

Subconical tubercle on heel, part of a series along outer edge of tarsus; inner edge of tarsus lacking tubercle or fold; inner metatarsal tubercle twice as long as wide, ca 3 times size of subconical outer metatarsal tubercle; supernumerary plantar tubercles at bases of toes with up to three tubercles in row proximal to fourth toe; toes bearing prominent lateral fringes; toe discs large, round, as large as those of outer fingers; subarticular tubercles round except for bifid distal subarticular tubercle of toe IV; tip of toe III reaches to middle of penultimate subarticular tubercle of toe IV, that of V to middle of distal subarticular tubercle of toe IV; heels overlapping when flexed hindlimbs held perpendicular to sagittal plane; shank 49.7-50.8 % SVL in males, 52.1 % in one female.

Brown above (between dorsolateral folds) with pale brown to tan dorsolateral folds bordered below by black band from eye to vent; canthal stripe faint (brown), no labial bars; flanks cream with black spots, forming a slanted bar about $\frac{1}{2}$ way between bases of limbs; arms pale brown except for cream wrist band and dark pigment atop digital disks; no limb bars; throat, venter, undersides of limbs cream with black spots; colorless area in groin and on posterior part of flanks; light brown stipple and black spots on anterior surfaces and posterior surfaces of thighs (with black spots in a row along ventral edge); no anal triangle.

In life, *E. baiotis* was described as follows: exposed surfaces yellow; flanks yellow with dark brown stripes; throat cream; dark brown spots on throat, venter, and hindlimbs; hidden surfaces of limbs yellow; anterior and posterior edges of thighs and posterior edge of tarsus with brown stripes; iris copper with dark brown flecks and fine lines (PMR fieldnotes, 25 May 1988).

Measurements of the holotype in mm. SVL 18.5, shank 9.2, HW 6.6, head length 6.9, chord of head length 7.3, upper eyelid width 1.5, IOD 2.1, tympanum length 0.8, eye length 2.5, E-N 2.0.

Referred specimen. Depto. Antioquia, Municipio Frontino, Km 16 carr. Nutibara-La Blanquita, alto de Río Cuevas, 2000 m (ICNMHN 16781).

Remarks. Most of our fieldwork was carried out below 1500 m where we did not observe either *E. baiotis* or *E. brevifrons* and we were able to collect the Quebrada Las Canoas only a single night (no one was anxious to repeat the adventure of riding mules up and down the steep trails at night and none of us was sufficiently enthusiastic to walk up to the site).

When I first did serious fieldwork in Colombia (1980), one of the sites we visited was the Parque Natural Nacional Munchique in Depto. Cauca. One of the frog species we collected appeared to match the illustrations in Cochran & Goin (1970) and I tentatively applied the name *Eleutherodactylus cabrerai* to that species. This identification was used by Kattan (1984), at my suggestion, when he reported frogs from Depto. Valle del Cauca. Subsequently (Lynch & Duellman, 1997; Ruiz-C. et al. 1996), I realized that the small frog from the Cordillera Occidental in Deptos. Cauca and Valle del Cauca was very different from *E. cabrerai*, a much larger frog found in Deptos. Antioquia and Caldas (Lynch & Rueda-A., 1997), and similar only in coloration.

Eleutherodactylus capitonis sp. nov. (Fig. 16)

Eleutherodactylus cabrerai: Kattan, 1984:322.

Holotype. ICNMHN 8124, an adult male, one of a series collected on 4 August 1980 by Victor Quijano and Pedro M. Ruiz.

Type-locality. COLOMBIA, Departamento de Cauca, Municipio de El Tambo, Parque Natural Nacional Munchique, vicinity of cabaña "La Romelia", 2610 m.s.n.m.

Paratotypes. Males ICNMHN 8125-26, 8128, 8131 (collected with holotype); ICNMHN 25784, 25860, 25930 (males collected 10 October 1990 by P. M. Ruiz et al.).

Paratypes. Colombia, Depto. Cauca, municipio El Tambo, Parque Natural Nacional Munchique, 2800 m, (male, ICN 39552, female ICN 39553, col. 1 July 1990 by A. Negret), Qda. Pozo Azul, 24 km NW Uribe, 2530 m (Males, ICNMHN 8132-34, females 8137-38, 8140-42, 8144-45), col. 4 August 1980 by Pablo Bernal, Oscar Pinto, and Pedro M. Ruiz; Depto. Valle del Cauca, municipio Cali, Farallones de Cali, campamento Corea, 2500 m (UVC 5873-74, 5878, 5882, 5884, 5886, 6854,

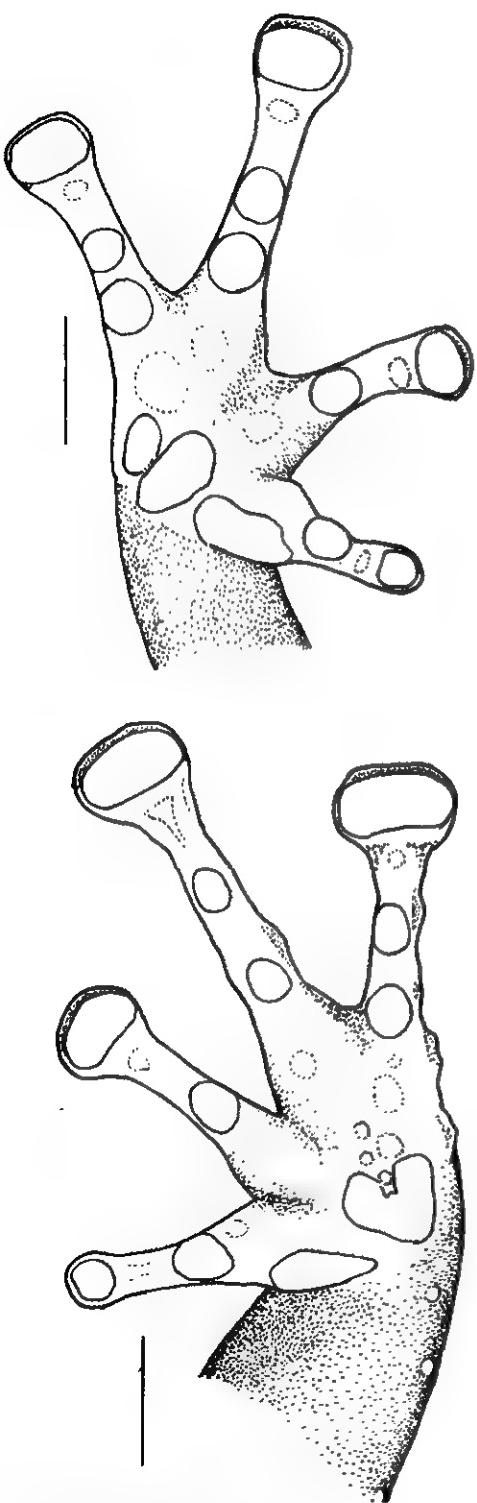


Figure 16. Palmar view of hands of *Eleutherodactylus capitonis* sp. nov. (top, ICN 8142) and *E. kelephus* sp. nov. (bottom, ICN 39640). Scales equal 2 mm.

males collected 22-23 January 1982, 27 Nov. 1982, by students, females UVC 5876, 5879, 11361-62, collected 23 Jan 1982, 9 Abril 1994, by students).

Etymology. Latin, *capitonis*, meaning one with a large head.

Diagnosis. (1) skin of dorsum smooth, that of venter areolate; dorsolateral folds low, to above groin; (2) tympanum small, not prominent; (3) snout round in dorsal and lateral profiles; canthus rostralis concave, not sharp; (4) upper eyelid bearing nonconical tubercles; no cranial crests; (5) vomerine odontophores oval, elevated, with oblique tooth rows; (6) males with vocal slits and white nuptial pads; (7) first finger shorter than second; round discs on fingers II-IV, larger than tympanum; (8) narrow lateral keels on fingers; (9) series of small ulnar tubercles, antebrachial largest; (10) small tubercle on heel, even smaller tubercles along outer edge of tarsus; indistinct inner tarsal fold on distal $\frac{1}{4}$ of tarsus; (11) two metatarsal tubercles, inner oval, 6-8 times size of round outer; (12) toes with lateral keels, no webbing; discs smaller than those of outer fingers; toe V long (to base of distal subarticular tubercle of toe IV); (13) dorsum brown with pale dorsolateral stripes, prominent dark bars on flanks, edged with cream; venter olive in males with darker slanting bars on throat, black with small white spots in females; posterior surfaces of thighs brown; (14) adults small, males 17.8-22.7 ($\bar{x} = 20.3 \pm 0.3$, N = 17) mm, females 25.3-28.9 ($\bar{x} = 27.0 \pm 0.4$, N = 9) mm SVL.

Eleutherodactylus capitonis is most similar to the smaller *E. verecundus* (males 18.0-21.9 mm, females 20.7-22.5 mm SVL) but *E. capitonis* has smooth skin on the dorsum (warty in *E. verecundus*), has nuptial pads (absent in *E. verecundus*), and has only small tubercles on the heel and tarsus (conical heel tubercle in *E. verecundus*).

Description (proportions are based on 17 males and 9 females). Head as broad as body in males, narrower than body in adult females; HW 38.1-42.1 ($\bar{x} = 39.5 \pm 0.2$) % SVL in males, 39.3-41.9 ($\bar{x} = 40.3 \pm 0.3$) % in females; snout subacuminate to rounded in dorsal view, rounded in lateral profile; nostrils weakly protuberant, directed dorsolaterally; snout short, E-N 64.0-90.9 ($\bar{x} = 76.6 \pm 1.6$) % eye length in males, 59.3-87.5 ($\bar{x} = 77.8 \pm 2.8$) % in females; canthus rostralis concave, not well-defined; lower real region concave, sloping gradually to lips; lips not flared; low tubercles on upper eyelid, upper eyelid width 68.2-110.5 ($\bar{x} = 91.9 \pm 2.7$) % IOD in males, 75.0-104.0 ($\bar{x} = 93.7 \pm 3.1$) % in females; no cranial crests; tympanum higher than long, its length 16.7-31.0 ($\bar{x} = 23.1 \pm 1.0$)

% eye length in males, 20.0-40.0 ($\bar{x} = 27.1 \pm 2.0$) % in females, its upper edge partially concealed by tuberculate supratympanic fold ending above insertion of arm, separated from eye by its length; posttritral tubercles subconical; choanae round, not concealed by palatal shelf of maxillary arch; vomerine odontophores smaller than a choana, oval, bearing oblique row of teeth, separated by distance equal width of an odontophore; tongue longer than broad, posterior border feebly notched, posterior 2/5 not adherent to floor of mouth; vocal slits lateral to tongue in males, vocal sac subgular.

Skin of dorsum smooth; very indistinct dorsolateral folds on upper flanks; venter areolate; discoidal folds well anteriad to groin; short anal sheath; row of 4 small ulnar tubercles; palmar tubercle bifid, about size of oval thenar tubercle; low supernumerary palmar tubercles; subarticular tubercles round, not projecting; narrow lateral keels on fingers; discs round, that on thumb smallest, those on fingers III-IV as large as tympanum (Fig. 16); first finger shorter than second; white nuptial pad on top of thumb in males.

Indistinct tubercle on heel; even less obvious tubercles along outer edge of tarsus; low tubercle along inner edge of tarsus; inner metatarsal tubercle twice as long as wide, 6-8 times size of low outer metatarsal tubercle; no more than one supernumerary plantar tubercle at base of toes III-IV, indefinite lateral keels on toes, no webbing; subarticular tubercles round, low; round discs on toes, smaller than those of outer fingers; tip of toe V to base of distal subarticular tubercle of toe IV, that of toe III reaches to middle of penultimate subarticular tubercle of toe IV, heels barely overlapping when flexed hindlimbs are held perpendicular to sagittal plane, shank 46.3-56.4 ($\bar{x} = 50.8 \pm 0.6$) % SVL in males, 50.2 - 55.7 ($\bar{x} = 52.5 \pm 0.7$) % in females.

Brown above with darker flanks bearing slanted dark brown bars, edged in cream; thin cream stripe from eye to above groin; limbs barred with black; venter brown with some cream spots laterally; dark chin strap; prominent anal triangle edged with cream; posterior surfaces of thighs brown; limb bars present on arms and thighs, poorly developed on shanks. Dorsum lacking pattern in most individuals (aside from thin cream dorsolateral stripes). In small specimens, interorbital bar and dorsal chevrons are obvious, limited laterally by pale dorsolateral stripe from flank pattern. Limb bars on shanks are narrow and oblique.

In life, *E. capitonis* is pale to dark brown, dark green, or almost orange-brown above; dorsolateral stripes rusty

orange; flanks darker, dark green to black with bronze to white lines outlining slanting bars; some white flecks on black venters of females; venter dull olive in males; throat, underside of limbs very dark brown in females, in males throat bearing dark olive slanted bars (outlined with cream); iris copper with black reticulation and reddish brown horizontal streak.

Measurements of holotype in mm. SVL 22.7, shank 11.6, HW 8.9, head length 8.0, chord of head length 8.8, upper eyelid width 1.9, IOD 2.2, tympanum length 0.7, eye length 2.7, E-N 2.2.

Natural history. Individuals were sitting on vegetation along the road and along streams at night. Juvenile males (no nuptial pads, no vocal slits) are 13.6-16.7 mm SVL whereas juvenile females are 15.5-22.1 mm SVL. A single young female (modest convolutions of the oviducts) is available and she is 23.4 mm SVL.

Referred specimens (juveniles). Depto. Cauca, El Tambo, vic. cabaña La Romelia, 2520 -2610 m (ICNMHN 8127, 8129-30, 25929, 25934, 25938-40, 25943), Qda. Pozo Azul, 24 km NNW Uribe, 2530 m (ICNMHN 8135-36, 8139, 8143), Qda La Torcaza, Km 25 al NNW Uribe, 2440 m (ICNMHN 26008); Depto. Valle del Cauca, Cali, Farallones de Cali, campamento Corea, 2500 m (UVC 5871, 6646, 6859).

Remarks. Although no synapomorphy has been identified, *E. capitonis* is thought to be the northern replacement of *E. verecundus*.

Lynch (1996) reported *E. calcaratus* (Boulenger) from several localities on the Cordillera Occidental in Depto. Valle del Cauca. However, further study of these and additional collecting on the Serranía de los Paraguas reveals that the frogs from the Serranía de los Paraguas represent a taxon distinct from *E. calcaratus*. *Eleutherodactylus calcaratus* (Fig. 2) is the same size as the new species, has similar proportions, but differs slightly in coloration (has a pale venter with thin dark reticulations and has pale spots on the concealed surfaces of the thighs) and has the dorsum uniformly covered with small tubercles, in contrast to the new species. In *E. calcaratus*, males are 16.9-22.9 ($\bar{x} = 20.8 \pm 0.4$, N = 15) mm and females are 27.7-33.1 ($\bar{x} = 29.2 \pm 0.5$, N = 11) mm SVL. Proportions are as follows (N for males = 14, for females = 11): Males — tibia/SVL 50.9-63.3 ($\bar{x} = 56.7 \pm 0.9$), HW/SVL 34.4-41.8 ($\bar{x} = 39.0 \pm 0.5$), upper eyelid IOD 81.8-136.8 ($\bar{x} = 107.6 \pm 3.8$), tympanum/eye 24.0 - 34.6 ($\bar{x} = 32.3 \pm 1.2$), E-N/eye 71.4-90.0 ($\bar{x} = 80.8 \pm 1.3$). Females — tibia/SVL 52.9-58.8 ($\bar{x} = 56.8 \pm 0.6$), HW

SVL 37.9-40.9 ($\bar{x} = 39.5 \pm 0.3$), upper eyelid/IOD 84.8-100.0 ($\bar{x} = 94.6 \pm 2.0$), tympanum/eye 32.5-40.5 ($\bar{x} = 36.3 \pm 0.7$), E-N/eye 83.3-100.0 ($\bar{x} = 94.8 \pm 1.7$).

Eleutherodactylus calcaratus has been collected at several places in the immediate vicinity of Cali. In addition to the type-locality (Cerro San Antonio, BMNH, UMMZ), the species has been found at Alto Pance (=campamento Corea), 2600 m; Dapa, bosque San Antonio; finca Zingara, 1900 m; Peñas Blancas, 1900 m; corregimiento La Castilla, Qda. Marin, 2000 m (all municipio Cali) and at finca San Pedro (municipio Dagua). The vast majority of specimens of this species are housed in the Museo de Historia Natural of the Universidad del Valle. Additionally, there is a record from Depto. Cauca: mpio. Piendamó, reserva El Guayabo (UVC 5933). To date, the species is known from localities at elevations between 1750 and 2000 m, where it remains an uncommon species accounting for a few per cent of the *Eleutherodactylus* taken in any one collection.

Eleutherodactylus kelephus sp. nov. (Figs. 6, 16-17)

Eleutherodactylus calcaratus (part): Lynch, 1996:332-334.

Holotype. ICN 39637 (JDL 21193) adult female, one of a series collected 25 July 1997 by Taran Grant and John D. Lynch.

Type-locality. COLOMBIA, Departamento Valle del Cauca: municipio El Cairo, vereda Las Amarillas, El Boquerón, quebrada 19.85 km del cementerio de El Cairo, 2140-2150 m.s.n.m.

Paratotypes. ICN 39649-63 (males) and 39635-36, 39638-48 (females) collected with the holotype.

Paratypes. Colombia, Depto. Valle del Cauca, mpio. El Cairo, Alto de Galápagos (UVC 9150, 9477-78), females collected 27 Feb.-1 Mar. 1987 by Jorge Restrepo; vereda Las Amarillas, 19.6 km del cementerio de El Cairo, 2110-2130 m. (ICN 39622-28, males, 39630, female), same date and collectors as holotype; 18.9 km del cementerio de El Cairo, 2060-2070 m (males ICN 39671-73, female 39669), 27 July 1997, El Boquerón, 2120-2200 m (males, UVC 12561, 12588, 12963, 13039, 13247, 13249, females UVC 12971, 13038, 13248), collected 1-2 April and 20-21 Sept. 1996 by W. Bolívar, F. Castro, and T. Grant.

Etymology. Greek, *kelephos*, meaning leper. The rounded pustules on the dorsal surfaces provide the impression of some disfigurement caused by leprosy.

Diagnosis. (1) Skin of dorsum with many round pustules, forming ridges (H-shaped figure on shoulders, transverse ridges above sacrum), that of venter areolate; no dorsolateral folds; (2) tympanum prominent, 1/4-1/3 eye length; (3) snout round in dorsal and lateral views; canthus rostralis concave, rounded; (4) upper eyelid bearing conical tubercle, slightly wider than IOD; no cranial crests; (5) vomerine odontophores prominent, oval, narrowly separated; (6) males with vocal slits, nuptial pads. (7) first finger shorter than second, outer fingers bearing broad discs; (8) fingers bearing lateral fringes; (9) ulnar tubercles subconical; (10) conical tubercle on heel; tu-

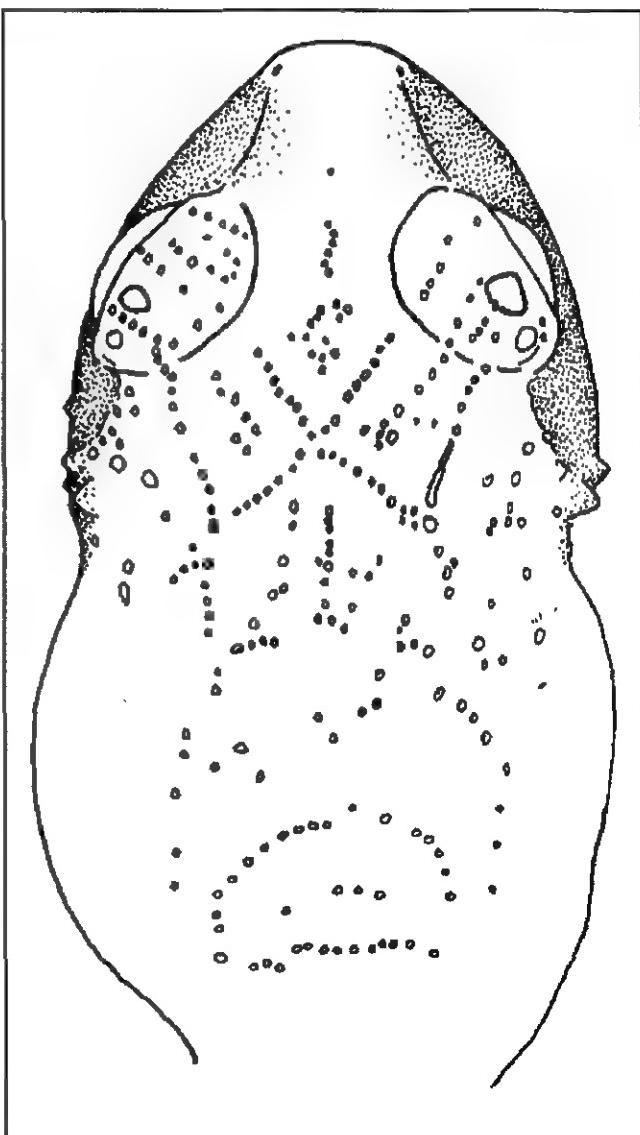


Figure 17. Distribution of warts on skin of dorsum in *Eleutherodactylus kelephus* (ICN 39640).

bercles along outer edge of tarsus; (11) two metatarsal tubercles, inner oval, 6-8 times size of round outer; (12) toes with lateral fringes, no webbing; toe discs expanded, smaller than those of fingers; fifth toe long (to base of distal subarticular tubercle of toe IV); (13) brown above with cream occipital H; chin bearing inverted dark brown triangle; venter dark brown to maroon with cream spots and reticulum; posterior surfaces of thighs uniformly brown; (14) adults moderate-sized, males 15.8-21.3 ($\bar{x} = 19.7 \pm 0.2$, N = 29) mm, females 27.0-31.5 ($\bar{x} = 29.3 \pm 0.2$, N = 21) mm SVL.

Eleutherodactylus kelephus is most similar to, and probably most closely related to, *E. calcaratus*, with which I had previously confused it, in part. The two frogs are the same size and exhibit the same proportions. They differ in that, in *E. kelephus*, the dorsal tubercles are reduced in number and form a distinct pattern whereas in *E. calcaratus*, the tubercles are distributed uniformly across the dorsum and are more numerous. In coloration, *E. kelephus* is much darker ventrally (the venter of *E. calcaratus* is cream with sparse brown reticulation) and has uniformly brown posterior surfaces of the thighs (in *E. calcaratus* these surfaces bear numerous large pale spots, *contra Lynch*, 1996).

Description (proportions based on 25 males and 21 females). Head wider than body in males, almost as wide as body in adult females, wider than long; HW 37.9-42.3 ($\bar{x} = 39.8 \pm 0.2$) % SVL in males, 38.4-42.0 ($\bar{x} = 40.6 \pm 0.2$) % in females; snout subacuminate in dorsal view in males, rounded in females, round in lateral profile in both sexes; E-N 69.7-96.4 ($\bar{x} = 84.2 \pm 1.3$) % eye length in males, 76.0-100.0 ($\bar{x} = 89.8 \pm 1.3$) % in females; nostrils protuberant, directed dorsolaterally; canthus rostralis evident but rounded, concave; loreal region concave, sloping gradually to lips; lips weakly flared in females; upper eyelid bearing many smaller nonconical tubercles and one conical tubercle on posterolateral quarter, its width 93.8-125.0 ($\bar{x} = 107.4 \pm 1.9$) % IOD in males, 82.5-117.2 ($\bar{x} = 97.1 \pm 1.9$) % in females; no cranial crests; supratympanic fold not distinct but obscuring upper edge of tympanum; tympanum round in males, slightly higher than long in females, separated from eye by its length; tympanum length 22.2-36.7 ($\bar{x} = 28.7 \pm 0.8$) % eye length in males, 26.1-36.8 ($\bar{x} = 31.6 \pm 0.6$) % in females; postrostral tubercles subconical; row of 3-4 small tubercles along lower margin of lower jaw; choanae subtriangular in outline, well medial of palatal shelf of maxillary arch; vomerine odontophores almost as large as choanae, median and posterior to choanae, oval, separated by distance equal $\frac{1}{2}$ width of an odontophore, each bearing trans-

verse row of 3-4 teeth; tongue longer than wide, its posterior border notched, posterior 2/5 not adherent to floor of mouth; short vocal slits near angles of jaws in males.

Dorsum with many rounded tubercles (pustules) forming H-shaped figure above scapulae, sagittal row between eyes, transverse rows above sacrum and pelvic girdle and scattered tubercles over rest of dorsal surfaces (Fig. 17); no anal sheath; pair of subanal tubercles; venter areolate; discoidal folds well anteriad to groin; upper surfaces of forearm, shanks with tubercles in rows (corresponding to edges of bars); four subconical ulnar tubercles; palmar tubercle bifid, twice size of oval thenar; numerous supernumerary palmar tubercles; subarticular tubercles round; fingers bearing lateral fringes with some tendency to be crenulate; discs round with broad ventral pads on fingers II-IV, thumb lacking expansion (Fig. 16); first finger shorter than second; white nonspinous nuptial pad over top of thumb and medial surfaces of thenar tubercle in males.

Tubercle on knee; conical tubercle on heel; row of 2-3 subconical outer tarsal tubercles; inner edge of tarsus lacking tubercles or fold; inner metatarsal tubercle 1 $\frac{1}{2}$ times as long as wide, 6-8 times size of round outer; few supernumerary plantar tubercles (bases of toes only); subarticular tubercles round; all toes bearing round discs (smaller than those of outer fingers); toes bearing narrow lateral fringes (= keels); tip of toe III to middle of penultimate subarticular tubercle of toe IV, that of toe V to base of distal subarticular tubercle of toe V; heels overlapping when flexed hindlimbs held perpendicular to sagittal plane; shank 51.5-59.6 ($\bar{x} = 55.2 \pm 0.4$) % SVL in males, 53.0-60.0 ($\bar{x} = 56.2 \pm 0.4$) % in adult females (57.3-60.3, $\bar{x} = 58.6$, N = 6, in juvenile females).

Brown above with pale (cream) ridges of tubercles; canthal-supratympanic stripe and labial bars reddish-brown; pale cream labial stripe; flanks spotted or reticulated with reddish-brown except for white spots along lower edges of flanks; limbs olive with cream ridges and half moons of dark pigment laterally (shanks, forearm); inner digits cream; prominent black bars atop tarsi; in females, venter brown with cream or white spots and lines, forming dark inverted triangle on chin-throat; groin and undersides of shanks black with large white spots; posterior surfaces of thighs dark brown with some cream flecks; in males, venter not spotted or bearing darker spots over a gray ground color; groin and anterior surfaces of thighs brown, without spots; undersides of shanks barred black and white; dark triangle (or pentagon) prominent on chin.

In life, *E. kelephus* is brown or maroon above (sometimes green) with darker markings; venter pale gold with heavy black markings to black or maroon with cream to white spotting; throat colored like venter or tan with brown or black inverted triangle; flanks black, maroon, or green with white to pale yellow spots (rarely red); gold interspaces between labial bars and above tympanum; posterior surfaces of thighs uniform brown; undersides of shanks black and white (females) or black and brown (many males); iris brown (sometimes brassy gold) with black reticulum.

Measurements of holotype in mm. SVL 31.4, shank 16.9, HW 13.1, head length 12.5, chord of head length 13.2, upper eyelid width 3.3, IOD 3.3, tympanum length 1.5, eye length 4.6, E-N 4.1.

Natural history. In earlier visits to El Boquerón, this species was uncommon but during our short visit in July 1997, we found *E. kelephus* to be very abundant along one small stream near the crest (a stream flowing south off Cerro El Inglés). The frogs appeared to be clumped, in association with certain herbaceous plants (not identified) along the stream. No reproductive activity was noted in 1997 and the earlier collections contained too few individuals to generate any impressions. Juvenile females (no convolutions of the oviducts) are as large as 26.0 mm SVL (UVC 12970). The relative scarcity of juveniles suggests that reproduction may be seasonal in this aseasonal forest.

Referred specimens (juveniles). Depto. Chocó: Alto de los Galápagos, 1980-2000 m (ICN 18284, 19425). Depto. Valle del Cauca: Topotypes (ICN 39664-68), 19.6 km del cementario de El Cairo, 2110-2130 m (ICN 39618-21, 39629, 39631-34), 18.9 km del cementario de El Cairo, 2060-2070 m (ICN 39670), El Boquerón, 2150 m (ICN 39674).

Remarks. Earlier, I (Lynch, 1996) confused this taxon with *E. calcaratus*. The two are certainly very similar structurally and in coloration but *E. calcaratus* has a more uniform distribution of tubercles over the dorsal surfaces and those tubercles are not pale. The coloration of the posterior surfaces of the thighs and the venter is the best means of distinguishing these two species (the venter is mostly cream in *E. calcaratus* and mostly black or brown in *E. kelephus*; and, the posterior surfaces of the thighs do not bear pale spots or flecks in *E. kelephus*). It is possible that *E. calcaratus* and *E. kelephus* represent opposite ends of a cline but there is no evidence for such a proposition aside from the observation that the two are "very similar", an observa-

tion lacking evidence for or against any particular hypothesis.

Two of the species described above (*E. angustilineatus* and *E. kelephus*) are found on the Serranía de los Paraguas. This region has been especially important in demonstrating the rich diversity of frogs of the genus *Eleutherodactylus* in western Colombia. One of the more surprising finds on this andean spur has been a series of very small frogs, what one might want to term nanobatrachians. These are difficult to collect because they are so small and once captured are very sensitive to the heat of the collector's hands. Very few individuals accumulated in the UVC collections, presumably because collectors presumed that these were juvenile *Eleutherodactylus* and wanted to avoid the grief of attempting to identify juveniles. The UVC specimens are mostly adult females. In 1991, 1995, and 1997, I made special efforts to collect these minute frogs enabling the acquisition of series including adult males and adult females of each of the three.

Eleutherodactylus myops sp. nov. (Figs. 7, 18-19)

Holotype. ICN 39684 (JDL 21060), adult female, one of a series collected 25 July 1997 by Taran Grant, Paul Gutiérrez, and John D. Lynch.

Type-locality. COLOMBIA, Departamento Valle del Cauca, Municipio El Cairo, vereda Las Amarillas, El Boquerón (límite con Depto. Chocó), 19.6 km del cementario de El Cairo, 2130 m.

Topoparatypes. Males (ICN 39689-92) and females (ICN 39685-88) collected with holotype; males (ICN 39708-17) and females (ICN 39693-707), same collectors, date as holotype, 19.85 km del cementario de El Cairo; males (ICN 39725-27) and female (ICN 39724), 18.9 km del cementario de El Cairo, 2060-2070 m, collected by J Lynch 27 July 1997; (ICN 29341) (females), (29312-14, 29329-30, 29343), collected 23-29 June 1991 by J. D. Lynch and P. M. Ruiz.

Paratypes. Colombia, Valle del Cauca - límite con El Chocó, El Boquerón, 2200-2250 m, males (ICN 29317, 29319, 29321-22, 29324-25, 29327-28), females (ICN 29316, 29318, 29320, 29323) collected 24-25 June 1991 by P. M. Ruiz, males (ICN 36922-24, 36927-29) and females (ICN 36920, 36925) collected 20 July 1995 by J. D. Lynch and Erik Wild; Valle del Cauca, municipio El Cairo, 20.2 km NW La Carbonera, "Alto de los Galápagos", 2100 m, females (UVC 8028, 9500) collected 14 May 1985 and 27 Feb.-1 Mar. 1987 by J. H. Restrepo,

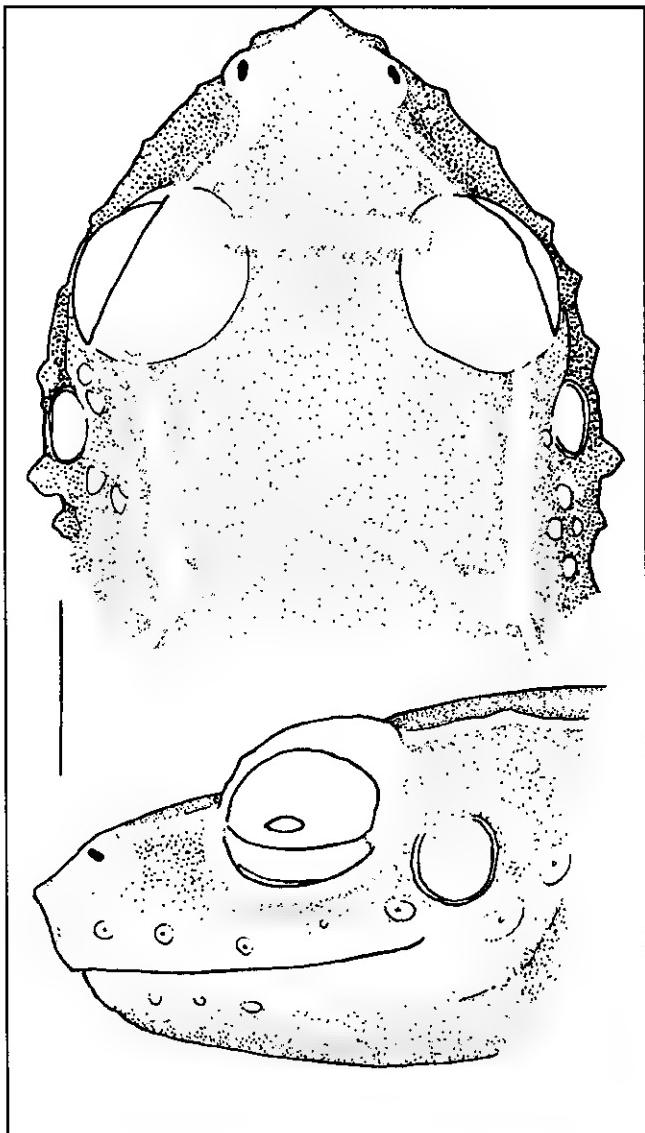


Figure 18. Dorsal and lateral views of head of *Eleutherodactylus myops* sp. nov. (ICN 29312). Scale equals 2 mm.

females (ICN 29379-81) collected 28 June 1991 by J. D. Lynch.

Etymology. Greek (*myops*) meaning near-sighted. The name is suggested by the presence of the interocular fold which fancifully resembles the bridge of a pair of glasses. However, the name is also appropriate for the author who was frustrated by having to wear reading glasses while collecting these minute frogs in the rain and mist of the Serranía de los Paraguas.

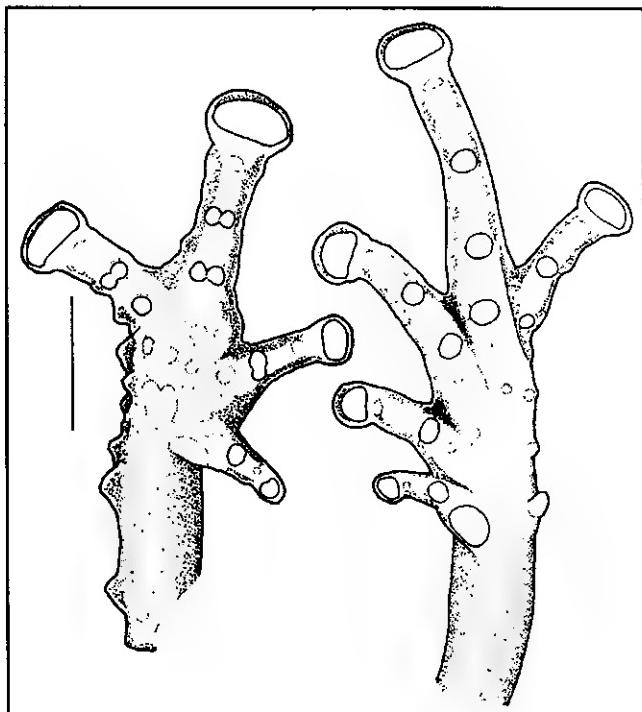


Figure 19. Plantar views of hand (ICN 29312) and foot (ICN 29314) of *Eleutherodactylus myops* sp. nov. Scale equals 2 mm.

Diagnosis. (1) Skin of dorsum bearing numerous flattened warts, that of venter areolate; no dorsolateral folds; (2) tympanum round, $\frac{1}{4}$ to $\frac{2}{5}$ eye length; (3) snout subovoid in dorsal view, rounded in profile, short; canthus rostralis rounded, concave; (4) upper eyelid lacking conical tubercles; fleshy interorbital fold present; no cranial crests; (5) no vomerine odontophores, (6) males with subgular vocal sac, no nuptial pad; (7) first finger shorter than second, lacking disc; outer fingers with expanded discs; (8) fingers bearing crenulate lateral fringes; (9) ulnar tubercles prominent, subconical; (10) short calcar on heel, subconial tubercles along outer edge of tarsus; conical tubercles on median surface of distal shank, (11) two metatarsal tubercles, inner oval, ca 6 times size round outer; (12) toes with lateral fringes, no webbing (except toe V partially fused to toe IV); toe discs smaller than those of fingers; fifth toe longer than third; (13) throat and chest black or dark brown; pale blotch on lower flank (yellow in life); dorsum usually brown with darker markings; (14) adults minute, males 10.9-13.6 ($\bar{x} = 11.9 \pm 0.1$, N = 34) mm, females 14.6-17.2 ($\bar{x} = 15.5 \pm 0.1$, N = 38) mm SVL.

Eleutherodactylus myops is most easily distinguished from all other species of the genus by its very small size and the presence of a fleshy interocular fold. It is most easily confused with the equally minute *E. quantus* (described below) but that species has conical tubercles on the upper eyelids (absent in *E. myops*), has the fifth toe free from the fourth (partially united by fleshy webbing in *E. myops*), and a yellow throat (black in *E. myops*).

Description (proportions based on 22 males and 30 females). Head as broad as body in males, narrower than body in adult females, broader than long; HW 34.9-41.1 ($\bar{x} = 37.8 \pm 0.3$) % SVL in males, 35.1-41.2 ($\bar{x} = 38.0 \pm 0.3$) % in females; nostrils protuberant, directed anterodorsolaterally; snout subovoid in dorsal view (with ill-defined tubercle at tip), rounded in lateral profile; E-N 62.5-93.3 ($\bar{x} = 80.5 \pm 1.5$) % eye length in males, 84.2-100.0 ($\bar{x} = 93.4 \pm 1.1$) % in females; canthus rostralis rounded but evident, weakly concave; loreal region concave, sloping gradually to lips; upper eyelid lacking tubercles, its width 60.0-100.0 ($\bar{x} = 78.8 \pm 2.4$) % IOD in males, 64.7-100.0 ($\bar{x} = 76.0 \pm 1.6$) % in females; transverse, fleshy, interocular fold (Fig. 18); tympanum prominent, round or slightly higher than long, upper edge concealed by fleshy supratympanic fold, separated from eye by about $\frac{1}{2}$ its length; tympanum length 23.5-47.1 ($\bar{x} = 39.4 \pm 1.2$) % eye length in males, 42.1-58.8 ($\bar{x} = 47.6 \pm 1.0$) % in females; two subconical postrostral tubercles; choanae oval (longer than wide), well medial of palatal shelf of maxillary arch; no vomerine odontophores; tongue as long as broad, lacking notch along posterior border, posterior 2/5 not adherent to floor of mouth; males with subgular vocal sac extending onto chest and long vocal slits lateral to tongue.

Skin of dorsum with numerous flattened tubercles, often fusing to form occipital W with short dorsolateral folds (attached to apices of W); no anal sheath; pair of large subanal tubercles; skin of venter areolate; discoidal folds well anteriad to groin; upper surfaces of lower arm, shank, and tarsus with flattened warts; 2-4 ulnar tubercles, flattened dorsoventrally, forming a continuous row with subconical tubercles (dorsoventrally flattened) along outer edge of palm; palm with numerous small round tubercles, thenar tubercle oval but palmar apparently broken up into small tubercles; subarticular tubercles bifid; thick lateral fringes on fingers rendering hand semipalmate (Fig. 19); discs and pads of fingers II-IV round, expanded, those of thumb not expanded; first finger shorter than second; males lack nuptial pads.

Dorsoventrally flattened, subconical tubercles on medial side of distal shank; short calcar on heel; 2-3 subconical tubercles along outer edge of tarsus; inner edge of tarsus smooth; outer metatarsal tubercle round, subconical, 1/6 size of oval inner; supernumerary plantar tubercles indistinct but present; fleshy lateral fringes on toes, fusing to form basal webbing (enclosing basal subarticular tubercles); toe V appears partially fused to toe IV (Fig. 19); subarticular tubercles round, low; toes II-V bearing round discs and broad pads (smaller than those of outer fingers), that of toe I not expanded; tip of toe V reaching about $\frac{1}{2}$ way between distal and penultimate subarticular tubercles of toe IV, that of toe III reaching about 1/3 of way between same subarticular tubercles (toe V longer than toe III); heels overlapping when flexed hindlimbs held perpendicular to sagittal plane; shank 49.6-61.0 ($\bar{x} = 55.8 \pm 0.6$) % SVL in males, 49.1-57.8 ($\bar{x} = 53.6 \pm 0.4$) % in females.

Brown above with diffuse darker markings (interorbital bar, sacral chevron, suprainguinal bar, slanted flank bars); canthal and labial markings darker brown; forearm and shank with brown bands, nearly as wide as interspaces, transverse, or nearly so, on shank; prominent dark brown anal triangle; throat gray, chest and venter heavily mottled with brown or black, often with scattered white flecks; undersides of limbs dark brown or black except that undersides of thighs often have substantial salmon to orange pigment; large pale area on posterior flank to groin, white or yellow in life; in males, undersides of limbs and lower venter often pale (orange or reddish in life). The mesorchium of males is white.

In life, *E. myops* is brown to reddish brown (rarely, pale green) above with darker dorsal markings; ventral surfaces are mostly black (black triangle visible on throat) except undersides of legs (orange or red); anterior surfaces of thighs reddish-orange; cream or yellow blotch on lower flank/groin; iris brown with slight orange cast.

Measurements of holotype in mm. SVL 15.6, shank 8.3, HW 5.8, head length 5.4, chord of head length 5.7, upper eyelid width 1.4, IOD 1.7, tympanum length 1.0, eye length 1.8, E-N 1.8.

Natural history. This minute frog is found on vegetation within one meter of the forest floor, usually in dense forest. In July 1997, we found the frog very abundant along a small stream flowing south off Cerro El Inglés. Many were found sitting at the tips of fern leaves as though they were attempting to maximize their access to water condensing from the air. In July 1997, amplexant pairs were found but no vocalizations were heard. On

other occasions, males of this tiny frog were calling within the forest. The call was described (JDL fieldnotes, 20 July 1995) as "a very musical series of chirps." Reproduction is apparently aseasonal because reproductive adults have been collected in February, May, June, and July. However, our failure to find juveniles during our visit in July 1997 when adults were very common suggests seasonality in reproduction. Juvenile males (no vocal slits) are 8.6-10.6 mm SVL and juvenile females (no oviductal expansion, convolution) are 9.8-13.7 mm SVL. Young females (small eggs but some indication of oviductal convolutions) are 13.5-14.4 mm SVL.

Referred specimens. Depto. Antioquia: municipio Frontino, corregimiento Nutibara, Km 21 carr. Nutibara

a La Blanquita, 1500 m (ICN 16639). Depto. Valle del Cauca: Topotypic male (ICN 29342); El Boquerón, 2200-2250 m (male, ICN 29326; females 29331-38, 36921, 36930).

Remarks. A single specimen (a juvenile female, 12.6 mm SVL) is available from the Murri transect, far to the north of the Serranía de los Paraguas. This specimen is accompanied by an excellent description of her colors in life and there is no question that it is an *E. myops*. This record is somewhat lower in elevation than those from the Serranía de los Paraguas and suggests that this minute species has been overlooked on the three intervening transects.

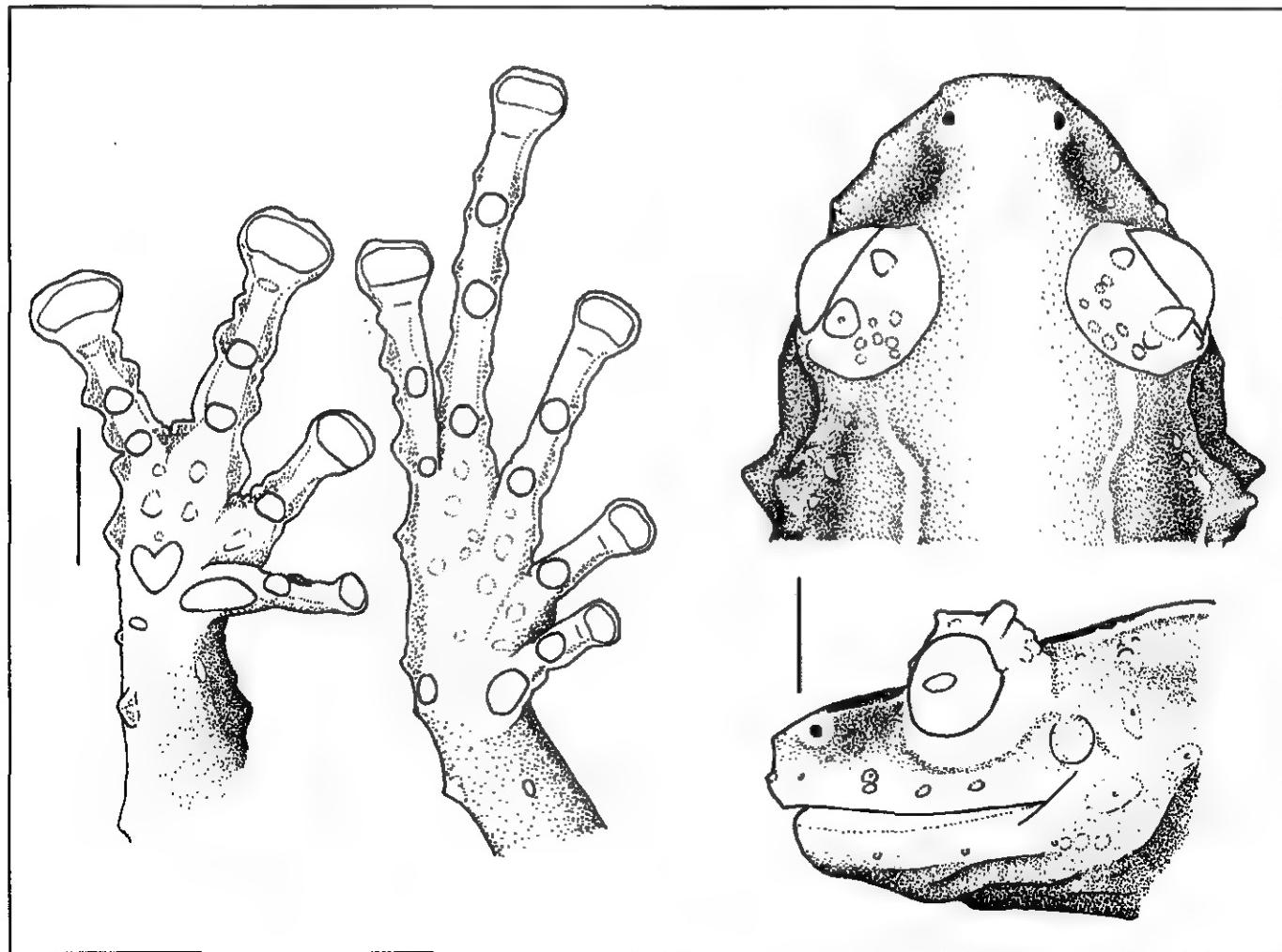


Figure 20. Dorsal and lateral views of head (ICN 39678) and plantar views of hand (ICN 39678) and foot (ICN 39680) of *Eleutherodactylus phalarus* sp. nov. Scales equal 2 mm.

Eleutherodactylus phalarus sp. nov. (Fig. 8, 20)

Holotype. ICN 39678 (JDL 21266), an adult female, one of series collected 26 July 1997 by John D. Lynch.

Type-locality. COLOMBIA, Departamento Valle del Cauca, Municipio El Cairo, vereda Las Amarillas, El Boquerón (límite con Depto. Chocó), 2160-2250 m.

Topoparatypes. ICN 36934-35, 39675-76, 39679, 39681-83 (males collected 20 July 1995 and 25-26 July 1997 by J. D. Lynch and E. Wild), ICN 39677, 39680 (females collected 25-26 July 1997 by J. D. Lynch).

Paratypes. Colombia, Depto. Valle del Cauca, municipio El Cairo, vereda Las Amarillas, Cerro El Inglés, 2400 m. UVC 9029-30 (males) and UVC 9020 (female) collected by Philip Silverstone and students, 27 Dec.-6 Jan. 1987.

Etymology. Greek (*phalaros*), meaning white-spotted. Used in reference to the color pattern on the concealed surfaces of the hindlimb and groin.

Diagnosis. (1) Skin of dorsum bearing flattened warts, that of venter areolate; no dorsolateral folds; (2) tympanum small, round; (3) snout rounded in dorsal and lateral profiles, deep; canthus rostralis rounded, concave; (4) upper eyelid bearing two conical tubercles, slightly narrower than interorbital space; no cranial crests; (5) vomerine odontophores in two small, prominent clumps, closely juxtaposed; (6) males with short vocal slits, no nuptial pads; (7) first finger shorter than second; fingers II-IV with expanded round discs; thumb disc not expanded; (8) crenulate lateral fringes on fingers; (9) ulnar tubercles subconical; (10) conical heel tubercle; non conical tubercles along outer edge of tarsus; (11) two metatarsal tubercles, inner oval, ca 4 times size of round outer; supernumerary plantar tubercles present; (12) toe fringes prominent, no webbing; toe discs expanded, smaller than those of fingers; fifth toe longer than third, not reaching distal subarticular tubercle of toe IV; (13) dorsum and venter brown with darker brown markings; V or Y-shaped mark on throat; groin, anterior surfaces of thighs, concealed shank and tarsus black with white spots; (14) adults small, males 15.3-17.6 mm, females 17.5-22.3 mm SVL.

By virtue of its small size, *E. phalarus* requires comparison with *E. myops* and *E. quantus*. From each it differs in having a pair of conical tubercles on its upper eyelid and by its somewhat spatulate, long snout. Like *E. myops*, it has crenulate fringes on the fingers but lacks the partial fusion of toes IV-V, has conical heel tubercles,

white (or yellow) spots on black fields in the groin and concealed surface of the shank, and is a larger frog.

Description (proportions based on eight males and five females, one a juvenile). Head as broad as body, longer than wide; HW 35.9-39.9 ($\bar{x} = 37.8 \pm 0.4$) % SVL in males, 37.1-39.8 ($\bar{x} = 38.4$) % in females; snout rounded in dorsal and lateral profiles, long; E N 80.0-94.7 ($\bar{x} = 87.2 \pm 2.5$) % eye length in males, 83.3-100.0 ($\bar{x} = 93.9$) % in females; nostrils protuberant, directed dorsolaterally; canthus rostralis rounded, concave; loreal region concave, sloping gradually to lips; lips not flared, bearing flattened or subconical tubercles (providing the curious outline to the head seen in Fig. 20); upper eyelid bearing two conical tubercles, more posterior longest (Fig. 20), plus smaller nonconical tubercles; upper eyelid width 70.6-100.0 ($\bar{x} = 88.5 \pm 4.2$) % IOD in males, 68.4 - 94.4 ($\bar{x} = 86.6$) % in females; no cranial crests; tympanum small, round, upper edge concealed by indistinct supratympanic fold; tympanum length 31.6-40.0 ($\bar{x} = 35.4 \pm 1.0$) % eye length in males, 25.0-36.4 ($\bar{x} = 30.2$) % in four adult females (one juvenile female has a tympanum 16.7 % eye length); postocular tubercles subconical in males, conical in females; series of subconical tubercles along edge of lower jaw; choanae oval (longer than wide) well median to palatal shelf of maxillary arch; vomerine odontophores median and posterior to choanae, elevated, separated medially by distance equal $\frac{1}{2}$ width of odontophore, vomerine teeth in two small clumps (1-2 teeth per odontophore), $\frac{1}{3}$ - $\frac{1}{4}$ size of a choana; tongue much longer than broad, not notched posteriorly, posterior $\frac{1}{2}$ not adherent to floor of mouth; vocal slits short, posterolateral to tongue; vocal sac subgular.

Numerous flattened warts over dorsal surfaces and flanks, partially fusing to form folds in scapular region, males much less tuberculate than females; venter areolate; discoidal folds well anteriad to groin; no anal sheath; pair of subanal tubercles; 3 conical ulnar tubercles; palmar tubercle bifid, twice size of oval thenar; numerous supernumerary palmar tubercles; subarticular tubercles round; lateral fringes of fingers prominent, crenulate (dorsoventrally flattened conical warts); discs of fingers II-IV round to weakly emarginate, expanded; disc of thumb not expanded; no nuptial pads in males.

Conical tubercle on heel; 3-4 subconical tubercles along outer edge of tarsus, continuing along outside of plantar surface; inner edge of tarsus lacking tubercle or fold; inner metatarsal tubercle oval; outer metatarsal tubercle $\frac{1}{4}$ size of inner, round, elevated; supernumerary plantar tubercles in rows corresponding to metatarsals; all toes bearing expanded discs (smaller than those of

fingers); toes bearing lateral fringes, less crenulate than those of fingers (Fig. 20); tip of toe III to distal edge of penultimate subarticular tubercle of toe IV, that of toe V reaches $\frac{1}{2}$ to $\frac{2}{3}$ way between penultimate and distal subarticular tubercles of toe IV; heels touching when flexed hindlimbs held perpendicular to sagittal plane; shank 44.9-52.6 ($\bar{x} - 49.7 \pm 0.8$) % SVL in males, 47.6-55.2 ($\bar{x} - 51.2$) % in females.

Dorsal surfaces brown to reddish brown with slightly darker spotting; labial bars and supratympanic stripe darker; canthal stripe poorly developed, if present; limb bars narrower than interspaces, oblique on shank; anal triangle not prominent; venter brown to nearly black with diffuse marbling; throat bears darker V or Y shaped figure with slanted bars posterolateral to central figure; groin, anterior surfaces of thighs, concealed surfaces of shank and tarsus black with white spots; posterior surfaces of thighs (behind knee) black with or without minute white flecks.

If life, *E. phalarus* is olive-brown above with rusty-brown markings, dark brown to nearly black below with darker inverted triangle on throat (throat paler than rest of ventral surfaces); posterior surfaces of thighs olive; black field in groin and on underside of shank, bearing white to pale yellow spots (groin spot sometimes orange or yellow with orange center); iris chocolate brown.

Measurements of holotype in mm. SVL 19.1, shank 9.1, HW 7.6, head length 7.6, chord of head length 8.2, upper eyelid width 1.8, IOD 2.0, tympanum length 0.8, eye length 2.2, E-N 2.2.

Natural history. Nearly all specimens of this distinctive species have been found on leaves 1-2 meters above the forest floor in very dense cloud forests. A few individuals were found along the stream flowing south off Cerro El Inglés in 1997 (the stream is not densely forested although in the bottom of its canyon the humidity remains very high even during dry weather [such as the area experienced in July 1997]). Unlike *E. myops* and *E. quantus*, *E. phalarus* is prone to jumping when headlamps shine on them.

Referred specimens. Depto. Valle del Cauca, municipio El Cairo, vereda Las Amarillas, Cerro El Inglés, 2400 m (UVC 9021-22, 9024).

Remarks. The UVC paratypes collected on Cerro El Inglés in 1986-87 are larger (males 17.0-17.6 mm, female 22.3 mm SVL) than the frogs I took at El Boquerón in 1995 and 1997 (males 15.2-16.7 mm, females 17.5-19.1 mm SVL). These two sites are within a linear kilo-

meter of one another and are at nearly the same elevation (I think the estimates of the height of Cerro El Inglés as 2500 m are too high). The samples currently available are too small about which to draw conclusions. At present, the samples do not permit an estimate of mean size in this species pending resolution of this apparent geographic or temporal variation in adult size.

In the collections of the ICN, there is a single specimen of what is surely the sister species of *E. phalarus*. This specimen (ICN 32052) is from the transect to the north (Risaralda, municipio Mistrató, Qda. Camaleon, 1560 m) and is an adult female 18.4 mm SVL. Unlike *E. phalarus*, this species lacks tubercles on the upper eyelid and has basal webbing of the fingers and toes.

Eleutherodactylus quantus sp. nov. (Figs. 9, 21)

Holotype. ICN 29340, an adult female obtained 29 June 1991 by John D. Lynch.

Type-locality. COLOMBIA, Departamento Valle del Cauca, Municipio El Cairo, vereda Las Amarillas, El Boquerón (límite con Depto. Chocó), 2100-2250 m.

Paratypes. ICN 29315, 29339 (males collected 24-29 June 1991 by J. D. Lynch and P. M. Ruiz).

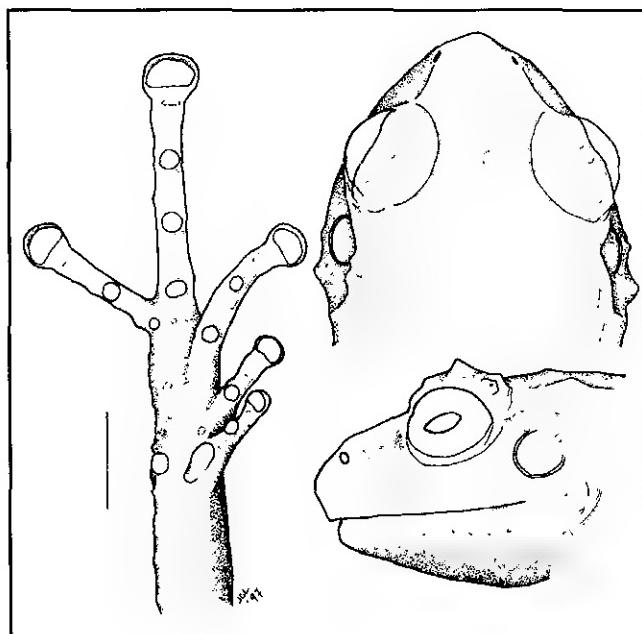


Figure 21. Dorsal and lateral views of head and plantar views of hand and foot of *Eleutherodactylus quantus* sp. nov. (ICN 39763). Scales equal 2 mm

Paratypes. Colombia, Depto. Valle del Cauca, municipio El Cairo, vereda Las Amarillas, 0.65 km below crest at El Boquerón, 2160 m (males ICN 39764-65, females ICN 39762-63), collected 25 July 1997 by J. D. Lynch; "Alto de Galápagos", 20.2 km NW La Carbonera, 2100 m (female ICN 29306) collected by J. D. Lynch 28 June 1991.

Etymology. Latin (*quantus*), meaning "How many?" in reference to my surprise at discovering yet another miniature species on the Serranía de los Paraguas.

Diagnosis. (1) Skin of dorsum smooth with scattered subconical tubercles, that of venter areolate; dorsolateral folds not well defined; (2) tympanum prominent, round, 2/5 - 3/5 eye length; (3) snout subacuminate in dorsal view, angularly rounded in lateral profile, with papilla at tip; (4) conical tubercle on upper eyelid, another between eyes; no cranial crests; (5) no vomerine odontophores or teeth; (6) males with subgular vocal sac, no nuptial pad; (7) outer fingers bearing dilated discs; first finger much shorter than second; (8) fingers bear fleshy lateral fringes; (9) ulnar tubercles conical; (10) small subconical tubercles on heel and tarsus; (11) two metatarsal tubercles, inner oval, ca 4 times size conical outer; (12) toes with expanded discs, fleshy lateral fringes, no webbing; fifth toe long; (13) dorsum brown with darker markings (green in life); throat cream (yellow in life); white spot on posterior flank (yellow with red center in life); (14) adults minute, males 11.6-14.5 mm, females 14.4-16.7 mm SVL.

Most similar to *E. myops* from which it differs in having tubercles on the upper eyelids, the fifth toe free of webbing, and in having a yellow patch (in life) on the throat.

Description (proportions based on four males and nine females). Head not as wide as body, wider than long; HW 34.4-36.6 ($\bar{x} = 35.8$) % SVL in males, 32.4-39.6 ($\bar{x} = 36.0 \pm 0.6$) % in females; nostrils protuberant, directed dorsolaterally; snout subacuminate (with papilla at tip) in dorsal view, almost protruding in lateral profile; E-N 70.6-87.5 ($\bar{x} = 80.6$) % eye length in males, 77.3-96.4 ($\bar{x} = 85.6 \pm 2.7$) % in females; canthus rostralis concave; loreal region concave, sloping abruptly to lips; upper eyelid bearing one conical tubercle and others less prominent (Fig. 21), upper eyelid width 76.7-89.3 ($\bar{x} = 82.2$) % IOD in males, 79.4-100.0 ($\bar{x} = 85.9 \pm 2.4$) % in females; conical tubercle in interorbital space; no cranial crests; supratympanic fold obscure; tympanum large, round, directed slightly posteriorly; tympanum length 38.9-60.0 ($\bar{x} = 50.6$) % eye length in males, 43.2-58.8 ($\bar{x} = 52.1 \pm 1.7$) % in females; tympanum narrowly separated from

eye; postocular tubercle subconical; subconical tubercles along lower margin of lower jaw; choanae round, well medial of palatal shelf of maxillary arch; no vomerine odontophores or teeth; only trace of odontophores is pair of slanted ridges posteromedial to choanae; tongue longer than wide, its posterior border not notched, posterior 3/5 not adherent to floor of mouth; vocal slits posterolateral to tongue; males with large subgular vocal sac.

Dorsum with scattered subconical tubercles; indefinite dorsolateral folds (series of flattened warts, partially fused, especially evident anteriorly); no anal sheath; pair of subconical subanal warts; skin of venter areolate; discoidal folds well anteriad to groin; 3-4 conical ulnar tubercles; palmar tubercle bifid, much larger than oval thenar tubercle; numerous supernumerary palmar tubercles; basal subarticular tubercles round, distal ones bifid; fingers with large round discs and broad pads except for thumb; disc of thumb not expanded but pad fully developed; fingers bearing thick fleshy lateral fringes, rarely crenulate, and comparable fold along outside of palm; thumb shorter than second finger.

No median tubercles on distal shank; heel with small subconical tubercle; outer edge of tarsus bearing row of tubercles only slightly smaller than that on heel; inner edge of tarsus bearing small tubercles on distal portion; inner metatarsal tubercle twice as long as wide, ca four times size of conical outer metatarsal tubercle; sole covered with low supernumerary tubercles; subarticular tubercles round; toes bearing fleshy lateral fringes and round discs; toe discs smaller than those of fingers; tip of toe III reaches to distal edge of penultimate subarticular tubercle of toe IV, that of toe V to base of distal subarticular tubercle of toe IV (Fig. 21); heels barely overlapping when flexed hindlimbs held perpendicular to sagittal plane; shank 49.6-54.7 ($\bar{x} = 52.3$) % SVL in males, 48.5-56.2 ($\bar{x} = 51.8 \pm 0.8$) % in females.

Dorsum pale brown with gray warts or pale brown with darker brown markings (canthal-supratympanic stripe, interorbital bar, dorsal chevrons); limb bars prominent; postaxillary blotch dark brown; white blotch on posterior flank; limb bars narrower than interspaces; anterior surfaces of thighs pale brown; posterior surfaces of thighs cream with brown reticulum; ventral surfaces cream with vague longitudinal stripes on throat and indefinite brown reticulum over venter (some individuals have venter heavily flecked with brown obscuring throat pattern).

In life, *E. quantus* is green and brown above with bright green interorbital bar (or spots on eyelids); chin

bears yellow (with some green tint) blotch in all females and some smaller individuals as well; venter black to brown with cream flecks; anterior surface of thigh red with yellow spot (sometimes a yellow spot on adjacent flank, larger, less well defined); iris pale gray with gray flecks; area below pupil is nearly white (J. D. Lynch fieldnotes, 28 June 1991).

Measurements of holotype in mm. SVL 15.9, shank 8.4, HW 5.8, head length 5.8, chord of head length 6.1, upper eyelid width 1.7, IOD 1.8, tympanum length 1.0, eye length 2.2, E-N 1.7.

Natural history. *Eleutherodactylus quantus* is microsympatric with the equally small *E. myops* and during fieldwork in 1997 the two species were mixed by collectors (the errors were evident during preparation of material). On amplexant pair was found in July 1997 (the male is 11.6 mm SVL, ICN 29339, amplexant with the holotype). The only apparent ecological separation is apparent contrasting the collections from El Boquerón and those from Los Galápagos. At the first site, *E. myops* is by far the more abundant species whereas at Los Galápagos, *E. quantus* is abundant while *E. myops* is rare. Juvenile females are 12.3-14.1 mm SVL.

Most of the specimens collected of this species (all but one of the series from Los Galápagos collected in 1991) are presently misplaced in the ICN collection, reducing my ability to completely describe the species and address variation.

Referred specimens (juveniles). Depto. Valle del Cauca, municipio El Cairo, vereda Las Amarillas, 0.65 km below crest at El Boquerón, 2160 m (ICN 39766-70), 18.9 km del cementario El Cairo, 2060-2070 m (ICN 39771).

Remarks. The realization (in 1991) that there were two minute *Eleutherodactylus* in the Serranía de los Paraguas came as a surprise. That surprise has not diminished, especially because these two appear to be closely related. Until adequate material is available to examine *E. quantus* osteologically, I tentatively consider them each other's nearest relative, in spite of the fact that they are fully sympatric with one another. If there is another close ally of this pair of species in the Cordillera Central or Cordillera Occidental, it is not known to me.

Eleutherodactylus ptochus sp. nov. (Fig. 10, 22)

Holotype. ICN 39780 (Ja 21101), an adult female, one of a series collected by Taran Grant, Paul Gutiérrez, and John D. Lynch 25 July 1997.

Type-locality. COLOMBIA, Departamento Valle del Cauca, Municipio El Cairo, vereda Las Amarillas, El Boquerón (límite con Depto. Chocó), 2100-2200 m.

Paratopotypes. ICN 39782-806 (males), 39807-08 (females) collected with holotype.

Paratypes. Colombia, Depto. Chocó, 20.5-22.5 km del cementario de El Cairo, 2150-2200 m, ICN 39772 (female collected July 1995). Depto. Valle del Cauca: Cerro Inglés, UVC 9155, 9159-60 (males), 9156-57 (females) collected 26 Feb. 1986 by J. H. Restrepo.

Etymology. *Ptochos*, Greek, meaning a beggar; in reference to the absence of anything distinctive about it and hence my reluctance to become excited about naming it.

Diagnosis. (1) Skin of dorsum nearly smooth, that of venter areolate; no dorsolateral folds; (2) tympanum small, 15-42 % eye length, poorly defined; (3) snout round in dorsal and lateral profiles, short; canthus rostralis rounded; (4) upper eyelid narrower than IOD, lacking conical tubercles; no cranial crests; (5) vomerine odontophores indistinct, slanted; (6) males with vocal slits, subgular vocal sac, white nuptial pads; (7) first finger shorter than second; thumb lacking disk, discs round on fingers II-IV; (8) no lateral fringes on fingers; (9) no ulnar tubercles; (10) no tubercles on heel or outer edge of tarsus; elongate tubercle on inner edge of tarsus; (11) two metatarsal tubercles, inner oval, 6-8 times size of round outer; numerous supernumerary plantar tubercles; (12) toes with lateral fringes, no webbing; toe discs as large as those of fingers; fifth toe very long; (13) cream above with brown markings, including narrow and/or incomplete canthal stripe; venter cream, stippled with brown; concealed surfaces of limbs brown with cream flecks; (14) adults small, males 16.7-19.8 ($\bar{x} = 18.5 \pm 0.2$, N = 29) mm, females 20.7-24.5 ($\bar{x} = 22.6 \pm 0.6$, N = 6) mm SVL.

Eleutherodactylus ptochus is most similar to an assembly of lowland species (*E. frater*, *E. librarius*, *E. ockendeni*, *E. taeniatus*) and their presumed upland relatives (*E. incomptus*, *E. quaquaversus*) which lack a canthal stripe and have a distinctive facial markings (Lynch, 1980). However, in *E. ptochus*, the canthal stripe is present, albeit poorly developed (Fig. 22). Additionally, it differs from these other species in lacking conical tubercles on the heel and/or upper eyelid, in having a snout that is round in dorsal view, and in being smaller in size.

Description (proportions based on 28 males and 15 females, of which six are adults). Head as wide as body, wider than long; HW 35.4-38.9 ($\bar{x} = 37.0 \pm 0.2$) % SVL in males, 36.5-40.8 ($x = 38.3 \pm 0.3$) % in females; snout round in dorsal and lateral views, short; E-N 69.2 - 91.7 ($x = 74.4 \pm 0.9$) % eye length in males, 72.7-81.5 ($\bar{x} = 76.8 \pm 0.8$) % in females; nostrils not protuberant, directed dorsolaterally; canthus rostralis rounded, concave; loreal region very slightly concave, sloping gradually to lips; lips not flared; upper eyelid bearing small flat tubercles; upper eyelid width 68.0-100.0 ($\bar{x} = 86.4 \pm 1.7$) % IOD in males, 69.2-100.0 ($\bar{x} = 84.5 \pm 2.3$) % in females; no cranial crests; supratympanic fold indistinct; tympanum obscure, lower part of annulus visible without desiccation; tympanum small, its length 23.1 - 41.7 ($\bar{x} = 29.3 \pm 0.7$) % eye length in males, 15.2-37.9 ($x = 30.1 \pm 1.5$) % in females, higher than long, separated from eye by distance equal its length to 1 $\frac{1}{2}$ times its length; postrostral tubercles low, indistinct; choanae small round, well medial of palatal shelf of maxillary arch; vomerine odontophores median and posterior to choanae, very low, slanted (easily overlooked), bearing a clump of 2-4 teeth, separated medially by distance equal twice width of an odontophore; tongue longer than wide, its posterior border notched, posterior 2/5 not adherent to floor of mouth; males have vocal slits lateral to tongue; vocal sac subgular, extending onto breast.

Skin of dorsum smooth except for small, flat warts on lower back and minute tubercles corresponding to postocular folds (marked by pigment); upper surfaces of limbs bearing small low warts; anal opening not extended in sheath; no perianal tubercles; skin of venter areolate; discoidal folds well anteriad to groin; arm slender; very indistinct tubercles along ventrolateral edge of forearm; palmar tubercle bifid, larger than oval thenar tubercle; supernumerary palmar tubercles numerous, low; subarticular tubercles round, nonconical; fingers lack lateral fringes or keels; all fingers with ventral pads; disk of thumb not expanded, those of fingers II-IV expanded, largest on fingers III-IV; first finger shorter than second; males with white nuptial pad.

Insignificant flat tubercle on heel with traces of similar tubercles along outer edge of tarsus; short fold-like tubercle on inner edge of tarsus; inner metatarsal tubercle 2 $\frac{1}{2}$ times as long as wide; outer metatarsal tubercle round, nonconical 1/6 1/8 size of inner; numerous supernumerary plantar tubercles; subarticular tubercles round, nonconical; lateral fringes on inner edges of toes, no webbing; toe disks about size of those of fingers, round; tip of toe III reaches distal edge of penultimate

subarticular tubercle of toe IV, that of V reaches distal edge of distal subarticular tubercle of toe IV; heels touching when flexed hindlimbs held perpendicular to sagittal plane; shank 45.6-52.9 ($\bar{x} = 49.2 \pm 0.4$) % SVL in males, 46.8-54.3 ($\bar{x} = 49.7 \pm 0.6$) % in females.

Dorsum cream to brown above with pale brown to dark brown markings (occipital W, interorbital bar, sacral chevrons, suprainguinal spots, and flank bars), limb bars narrower than interspaces, oblique on shanks; subocular labial bars prominent, edged with white; supratympanic stripe dark brown; canthal stripe brown, varying from small blotch at anterior edge of eye to a thin complete canthal stripe (in some individuals, anterior labial stripe present and continuous with canthal stripe); ventral surfaces brown (pale to dark, corresponding to darkness of dorsal pigmentation); concealed surfaces of hindlimb and groin brown with cream flecks; anal triangle brown with indefinite cream line bordering it dorsally.

Some individuals have a thin cream middorsal line superimposed on the color pattern. Others have a pale interorbital bar just anterior to the dark interorbital bar.

In life, *E. ptochus* is tan, reddish-brown, or brown above with some nearly black markings as well as brown ones; ventral surfaces cream to grey; concealed limb surfaces same color as venter; iris yellowish (with metallic cast), with red horizontal streak and black reticulation.

Measurements of holotype in mm. SVL 23.5, shank 11.0, HW 8.6, head length 8.5, chord of head length 9.1, upper eyelid width 2.4, IOD 2.6, tympanum length 0.7, eye length 3.1, E-N 2.5.

Natural history. In July 1997, this species was very conspicuous at El Boquerón, sufficiently so that its *nom de recherche* in the field was "common". In previous years, the species was only rarely found at El Boquerón (1986, 1995) or not found at all (1991). What makes 1997 so unusual was that the habitat was abnormally dry. In 1997, most of the specimens of *E. ptochus* were found on a hillside forest away from any streams, a place that we did not investigate in 1991 or 1995. In 1997 we found a moderate number of *E. ptochus* along a stream slightly higher than the hillside forest. This stream is the actual type-locality for *Cochranella armata* and *E. myops* and was visited in 1991 (in quest of *C. armata*). In 1991, obviously we found no *E. ptochus* there and found very few *E. kelephus* whereas in 1997, each, especially the latter, was obvious along that stream.

Few hypotheses seem attractive to explain why a species should be abundant in a relatively dry facies during a dry epoch when discussing such a wet cloud forest as that of the Serranía de los Paraguas. That some species normally common should be uncommon during a drought cycle or in a drier microhabitat would be unremarkable. The only hypothesis that seems available is that *E. ptochus* is normally a species of the canopy that moved to nearer the forest floor during a period of exceptionally dry weather. This hypothesis could be tested readily by returning to the Paraguas during "normal" weather and contrasting collections made at ground level with those made in the canopy.

Juvenile males are 13.6-14.5 mm SVL whereas juvenile females are 12.5-20.8 mm SVL. The few young females (showing some traces of convolutions of the oviducts) are 20.0-21.3 mm SVL.

Remarks. Lynch (1980) reported *E. taeniatus* from not only the lowlands of northwestern Colombia but also from highland areas in the northern parts of the western cordilleras. Aside from some size differences (montane frogs are larger than those from the lowlands), he could not and did not distinguish what are certainly distinct species. Collecting over the past decade has revealed that there is a suite of small drab frogs distributed over much of the wetter parts of northern Colombia. A few of these can be distinguished based on color patterns but the majority are phenetically similar (at least in preservative). *Eleutherodactylus ptochus* is somewhat surprising because it is so small, in spite of being a species from comparatively high altitudes.

Referred specimens (juveniles): Depto. Chocó: 20.5-22.5 km del cementerio de El Cairo, 2080-2200 m (ICN 39773-79, 39826-27). Depto. Valle del Cauca: El Cairo, Las Amarillas, 19.6 km del cementerio de El Cairo, 2110-2130 m (ICN 39781, 39709-21), 19.85 km del cementerio de El Cairo, 2140-2150 m (ICN 39822-25).

The last species described here is arguably a species of the lowlands that also occurs in the lower edge of the cloud forest rather than a species of the cloud forests. It has had a checkered history because some of the specimens were confused with *E. cruentus* by me in earlier papers.

Eleutherodactylus sanguineus sp. nov. (Figs. 11, 23-24)

Eleutherodactylus cruentus (part): Lynch et. al. 1994:10-11, 39.

Holotype. ICNMHN 37833, an adult female from a series collected by J. Vicente Rueda & Fabio Quevedo, 29 February 1992.

Type-locality. COLOMBIA, Departamento del Antioquia, Municipio de Frontino, 0.9-1.9 km N La Blanquita (Murri), ca 800 m.s.n.m.

Paratopotypes. Males (ICN 37837-41, 37847-51), females (ICNMHN 37834, 37843), collected with holotype.

Paratypes. Colombia, Depto. Antioquia, municipio de Dabeiba, campamento Ingeominas "Pantanitos", río Amparradó, 805 m, cols. J. M. Renjifo y V. Corredor, sept. 9-12 de 1981, males (ICNMNH 10565-67, 10569-

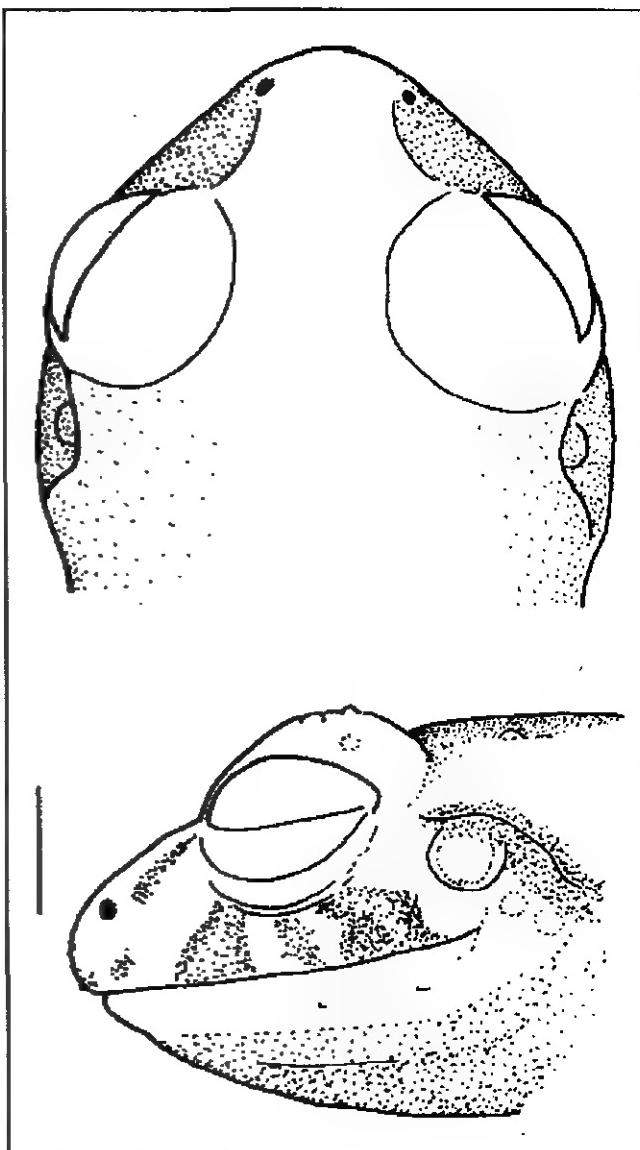


Figure 22. Dorsal and lateral views of head of *Eleutherodactylus ptochus* sp. nov. (ICN 39807). Scale equals 2 mm

71, 10613, 10619, 34863), females (ICNMHN 10582, 10635, 10639); municipio de Frontino, Km. 21, carretera Nutibara a La Blanquita, 1500 m, cols. P. M. Ruiz y J. V. Rueda, julio 18-19 de 1987, males (ICNMHN 16644-45); Km. 23, carr. Nutibara-La Blanquita, 1460 m, cols. J. V. Rueda et. al., 29 feb de 1992, male (ICNMHN 37852); Km. 27, carr. Nutibara-La Blanquita, 1140 m, cols. Ruiz y Rueda, julio 19-23 de 1987, males (ICNMHN 16649, 16873, 16875), females (ICNMHN 16665, 16668), misma localidad, 1080 m, cols. J. V. Rueda y F. Quemado, marzo 2, 1992, females (ICNMHN 37854-55, 37857); 2.5 km NE La Blanquita, cols. Rueda y Quemado, febrero 27 de 1992, 800 m., males (ICNMHN 37829-32), female (ICNMHN 37827); Parque Natural Nacional Las Orquídeas, vereda Venados, Qda. Alto Bonito, 820-890 m., cols. M. C. Ardila y P. M. Ruiz, mayo 31 de 1988, macho (ICNMHN 19361); Qda. Arenales, 950 m., col. M. C. Ardila, mayo 30 de 1988, male (ICNMHN 19333); Qda. El Retiro, 850-950 m., cols. J. D. Lynch, R. Sánchez, O. Sánchez, mayo 31 de 1988, machos (ICNMHN 19336, 19338, 19341), female (ICNMHN 19335); Qda. La Miqera, 1030-1060 m., cols. J. D. Lynch, P. M. Ruiz, y O. Sánchez, mayo 29-30 de 1988, males (ICNMHN 19316, 19326). Depto. Chocó, municipio Bajo Baudó, Pizarro y Delta 13, female (UVC 12876), col. V. Rojas, 23-28 Aug. 1996; municipio Carmen del Atrato, Km. 23, carr. Carmen del Atrato a Quibdó, 1030 m., cols. M. C. Ardila, P. M. Ruiz, y R. Sánchez, agosto 25 de 1987, female (ICNMHN 17036); Km. 44, carr. Carmen del Atrato-Quibdó, 630 m., cols. Ardila, Ruiz y Sánchez, agosto 22 de 1987, male (ICNMHN 17143). Depto. Risaralda, municipio Mistrató, Inspección de Policía Jeguadas, 1280-1320 m., junio 27 de 1992, male (ICNMHN 31964); camino a Puerto de Oro y camino a Río Curumay, 1280-1300 m., cols. M. C. Ardila et. al., junio 26-27 de 1992, males (ICNMHN 31956-57), females (ICNMHN 31934-35, 31938, 31940-45, 31947); municipio Pueblorica, vereda Borrató, Qda. Borrató, Km. 14, carr. Pueblorico a Santa Cecilia, 950 m., col. agosto 22 de 1987, male (ICNMHN 17143).

Diagnosis. (1) skin of dorsum very fine shagreen, that of venter areolate; no dorsolateral folds; (2) tympanum prominent, its length 1/5 to 1/3 eye length; (3) snout subacuminate in dorsal view, rounded in lateral profile; canthus rostralis straight; (4) upper eyelid bearing one subconical tubercle, broader than IOD; no cranial crests; (5) vomerine odontophores prominent; (6) males lack vocal slits, have nuptial pads; (7) first finger shorter than second; discs expanded, round on fingers II-IV; (8) fingers bearing lateral fringes; (9) ulnar tubercles small, forming series; (10) small, nonconical tubercle on heel;

no outer tarsal tubercles; short fold on inner edge tarsus; (11) two metatarsal tubercles, inner oval, ca 4 times size of round outer; few supernumerary plantar tubercles; (12) toes with thin lateral keels, no webbing; discs round, smaller than those of outer fingers; toe V very long; (13) dorsum tan, cream, or pale brown with darker mottling (green in life with brown markings), venter cream with dense brown stippling; pale spots on posterior flanks of males (yellow in life), lower flanks and posterior surfaces of thighs black with white flecks (yellow in life) in females; (14) adults moderate - sized, males 16.9-24.0 ($\bar{x} = 20.9 + 0.2$, N = 49) mm, females 29.1-35.2 ($\bar{x} = 32.8 + 0.3$, N = 30) mm SVL.

Most similar to *E. cruentus* and *E. latidiscus*. Unlike the former, *E. sanguineus* has the tympanum readily visible in adults of each sex and is a smaller frog. Unlike *E. latidiscus*, *E. sanguineus* lacks outer tarsal tubercles and is a smaller frog.

Description (proportions based on 16 males and 16 females). Head broader than body in males and juveniles, narrower than body in adult females; HW 37.4-42.2 ($\bar{x} = 39.0 + 0.3$) % SVL in males, 37.8-42.2 ($\bar{x} = 40.8 + 0.3$) % in females; snout subacuminate (or acuminate) in dorsal view, rounded in lateral profile; E-N 80.5-96.6 ($\bar{x} = 88.5 + 1.2$) % eye length in males, 90.0-107.1 ($\bar{x} = 98.7 + 1.2$) % in females; nostrils weakly protuberant, directed laterally, canthus rostralis obvious, edge rounded, straight; loreal region slightly concave, sloping abruptly to lips; lips not flared; upper eyelid width 95.2-133.3 ($\bar{x} = 108.9 + 3.0$) % IOD in males, 76.5-109.4 ($\bar{x} = 98.4 + 2.2$) % in females; upper eyelid bearing subconical tubercle in posterolateral quarter (Fig. 23); no cranial crests; tympanum round in males, slightly higher than long in females, annulus thin, its length 21.9-35.7 ($\bar{x} = 28.3 + 1.0$) % eye length in males, 21.7-35.7 ($\bar{x} = 29.0 + 0.8$) % in females, separated from eye by distance equal 1 1/2-2 times diameter of tympanum; postocular tubercles subconical; choanae round, not concealed by palatal shelf of maxillary arch when roof of mouth is viewed from directly above; vomerine odontophores median and posterior to choanae, triangular in outline, each about size of a choana, bearing a transverse row of 5-6 teeth, separated medially by distance equal 1/2 odontophore width; tongue longer than wide, its posterior border lacking notch, posterior 2/5 not adherent to floor of mouth; males lack vocal slits and sac.

Skin of dorsum very fine shagreen (appears smooth) with low postocular ridges; flanks bearing granules; skin of venter areolate; discoidal folds well anteriad to groin;

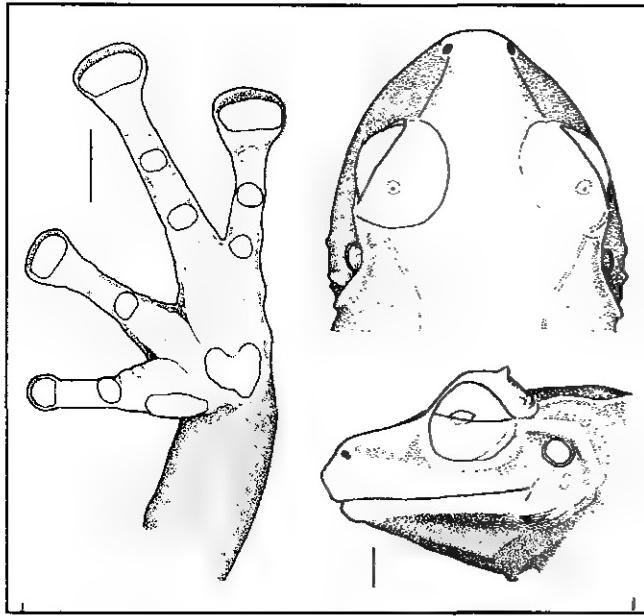


Figure 23. Dorsal and lateral views of head (ICN 16765) and palmar view of hand (ICN 17036) of *Eleutherodactylus sanguineus* sp. nov.

Scales equal 2 mm.

no anal sheath; perianal tubercles small; series of four nonconical small ulnar tubercles; palmar tubercle bifid, twice size of oval thenar tubercle; numerous, low supernumerary palmar tubercles; subarticular tubercles round, nonconical; fingers long, slender, bearing prominent lateral fringes (Fig. 23); discs round, that of first finger scarcely expanded; pads broader than long; first finger reaches to base of disc of second when each is appressed equally; males with white nuptial pads.

Round or subconical tubercle on heel; short, disconnected fold on distal 1/3 of tarsus; no outer tarsal tubercles, inner metatarsal tubercle 2 ½ times as long as broad, about 4 times size of round outer metatarsal tubercle; supernumerary plantar tubercles at bases of toes; subarticular tubercles round, nonconical; toes bearing thin lateral keels, no webbing, toe discs round, smaller than those of outer fingers; tip of toe III reaches to distal border of penultimate subarticular tubercle of toe IV, that of toe V reaches to middle or distal border of distal subarticular tubercle of toe IV; heels overlapping when flexed hind limbs are held perpendicular to sagittal plane; shank 51.7-60.7 ($\bar{x} = 55.3 + 0.3$) % SVL in males, 51.3-57.4 ($\bar{x} = 54.9 + 0.5$) % in females.

Dorsum brown with indistinct paler markings and cream lines along canthus rostralis and postocular folds

(and polymorphic, see below); canthal-supratympanic stripe dark brown; labial bars brown; flanks heavily pigmented; limb bars brown, perpendicular, about as broad as pale brown interspaces; venter cream with fine brown stipple, most dense on undersides of legs and throat; in males, often with a brown half-moon mark at anterior edge of lower jaw; in males, pale spots (size of disc of finger II or larger) on posterior flank, posterior surfaces of thighs brown with cream spots (larger than those of females, smaller than those of groin); in females, groin, concealed surfaces of hindlimb black with minute white spots.

Eleutherodactylus sanguineus exhibits color pattern polymorphisms based on the presence/absence of pale (lacking pigment in alcohol) interocular bands, an anal patch, a heel patch, and a pale blotch on the lower back (edges ill-defined). Most individuals (64.3%) lack these pale areas and have a pattern of ill-defined darker markings over the dorsum. However, 23.1 % exhibit a morph (A1) in which pale areas are seen on the back, heel, and rump (Fig. 24A). In life, these pale areas are cream or pale brown. Another morph (B, Fig. 24B) has a pale interocular bar bordered anteriorly by a dark brown or black bar. In life the pale bar is canela or pale brown.

In life, *E. sanguineus* is usually olive green or dark olive green above and less commonly brown with cream or green sacral spots; lower flanks and concealed surfaces of hindlimbs black with white flecks in females, lemon yellow spots in groin of males; throat and venter cream with dense brown stippling; iris bright copper or red with black reticulum; some females, perhaps in better light, were described as having the upper half of the iris orange or burnt orange, the lower half bronze or grey, with black reticulations and a brown horizontal streak

Measurements of holotype in mm. SVL 31.4, shank 16.5, HW 12.5, head length 13.2, chord of head length 13.6, upper eyelid width 3.2, IOD 3.5, tympanum length 1.4, eye length 4.5, E-N 4.2.

Natural history. Juvenile males are 15.6-17.2 mm SVL whereas juvenile females are 17.4-28.4 mm SVL The presence of juveniles in most samples suggests that reproduction is a seasonal. Young females, perhaps including some nearly ready to breed, are 26.9-29.0 mm SVL.

Referred specimens (juveniles). Depto. Antioquia, Dabeiba, campamento Ingeominas "Pantanitos", río Amparradó, 805 m (ICNMHN 10568, 10572, 10580, 10583, 10612, 10614, 10616-17, 10620, 13872); Frontino, Km. 23, carr. Nutibara-La Blanquita, 1430-1460 m

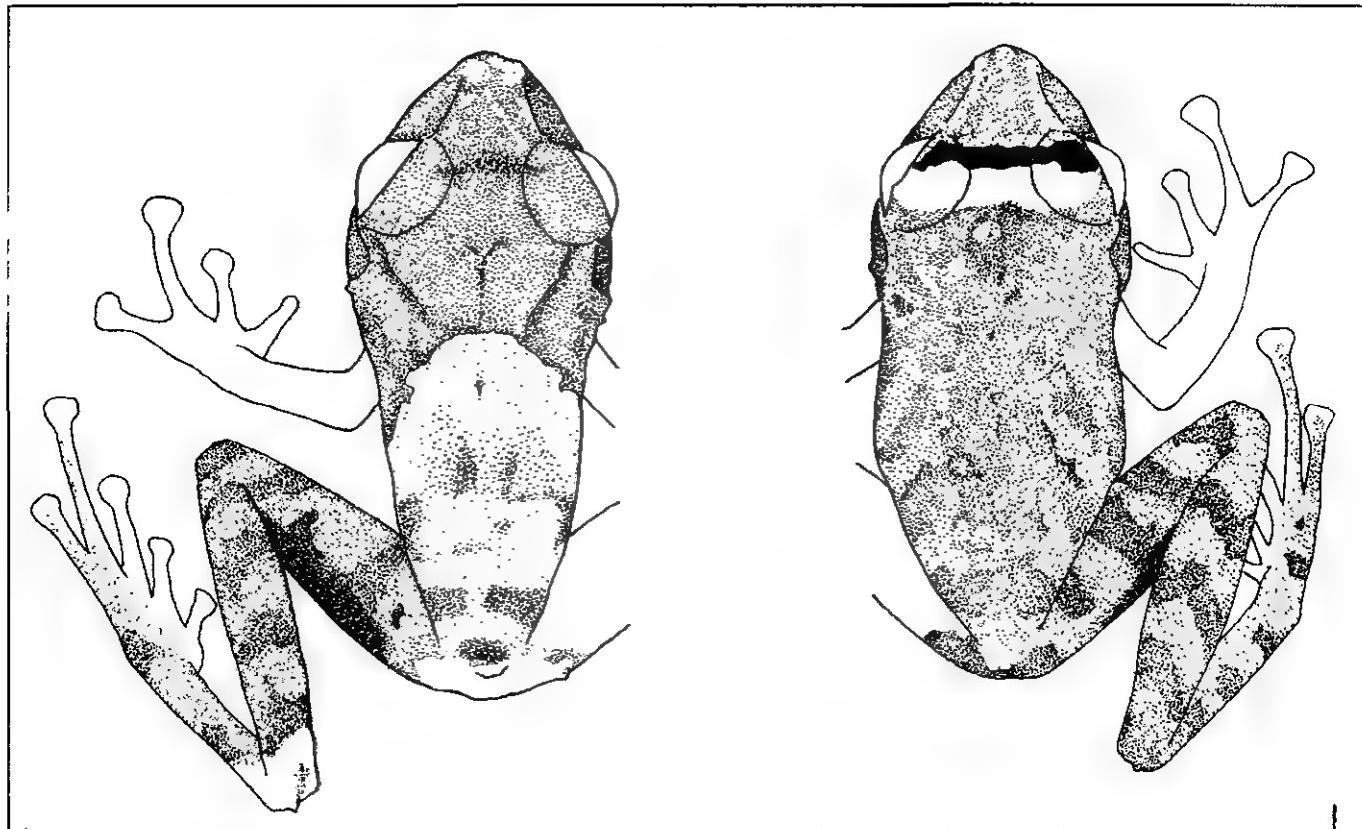


Figure 24. Dorsal pattern morphs of *Eleutherodactylus sanguineus* sp. nov. A (ICN 31982); B (ICN 31988)

(ICNMHN 16635-36, 37853), Km. 27, carr. Nutibara-La Blanquita, 1080-1140 m (ICNMHN 16650, 16766-67, 16769, 37856), carr. Nutibara-La Blanquita (ICNMHN 37858-62); 0.9-1.9 km N La Blanquita (ICNMHN 37835-36, 37844-86), 2.5 km NE La Blanquita, 800 m (ICNMHN 37858); Parque Natural Nacional Las Orquídeas, vereda Venados, Qda. El Retiro, 850-950 m (ICNMHN 19349-50, 19356-59), Qda. La Miquera, 1030-1060 m (ICNMHN 19319, 19321, 19327). Depto. **Risaralda**, Mistrató, Inspección de Policía Jeguadas, camino a Río Currumay, 1280-1300 m (ICNMHN 31742, 31952); Pueblorico, Km. 5, carretera Pueblorico Villa Claret, 1450 m (ICNMHN 17137). Depto. **Valle del Cauca**, Buenaventura, Bahía de Málaga, Fuente de Materiales, Base Naval del Pacífico (UVC 8922, 8930).

Distribution. The occurrences of *E. sanguineus* along the Pacific coast was initially a surprise to me but matches, more or less, the pattern of distribution of *E. zygodactylus*, a larger less easily overlooked frog (Lynch & Ardila-R., 1993). These two species present a distri-

butional pattern quite unlike those of other species in the Pacific lowlands, one in which the frogs appear to cling to some upland areas and to avoid the lowlands associated with the Atrato and San Juan rivers. Such a pattern of distribution in frogs suggests a once wider distribution now fragmented by climatic shifts (a vicariance, not dispersalist, explanation).

Discussion

With these descriptions, I think I have identified all of the species of *Eleutherodactylus* of the Cordillera Occidental (minimally, I have put names on all of the undescribed species known to me over the past decade of collecting, although a few are represented by manuscript names or by inadequate material). It is appropriate to summarize the distributions of these taxa and to update and expand the table published by Ruiz-C et. al. (1997). Although there is obviously some arbitrariness in assigning species to "lowlands" or uplands (for example, *E. anatipes* and *E. sanguineus*), I have long thought of these species as denizens of either the low

Tabla 3. Distribuciones altitudinales y geográficas de las 76 especies del género *Eleutherodactylus* de las vertientes occidentales de la Cordillera Occidental y Macizo del Pasto. En cada célula (especie por transecto), se encuentran los límites de altitudes de sitios. Una estrella se indica que no hay registros pero se presume que la especie está en el transecto

Species	La Planada	Munchique	Farallones	Catíma	Paraguaná	Risaralda	Carmen	Urrao	Murri	Antadó
acatallelus		2190-2610	2600	*	2100-2250	2430				
B					1850-1860	1540-1880	*	1410-2170	1430-1960	
aemulatus								1410-1430		
albernicoi					950					
anatus	1200-1600	800-1240	800-1100							
angustilineatus			1900	*	1850-2100	1700-2300				
apiculatus	1780									
appendiculatus	2000									
aurantiguttatus					1490-1510	*	*	1410-1540	1000-1900	1500
babax	1600-1780	1200-1500	1750-2100	*	1900-2250	1600	*	*	1900-1940	1500
baotia								1780-1870	1960	
bellona								1400-1870	1100-2000	
boulengeri		2520-2740	*	*	*	*	*	2430-2490		
brevifrons		2190-2810	1650-2100	*	1900-2250	1400-2430	*	1770-1870	1140-2000	
buckleyi	3230	3050								
cabrerae								1770-1870	1140-1940	
cacao		2190-2600								
cadernai										1900
calcaratus			1750-2100							
calcarulatus	?									
capitonis		2440-2800	2600							
celator	1780-2600									
cerastes	*	1000-1580	1750-2000	1590	1900-2250	1700-1950	*	1480-1870	1430-1900	
cheiroplethus					1410-1450	1380	*	1290-1540	800-1460	1500
chrysops			1900-1950	900	2100-2130					
colomai	1055-1120									
degener	1020-1400									
dainops			1750-2600	*	1900-2250					
diaphonus				1180-1250						
diogenes		1470-1600								
duelimanii	1780	2180								
eremita	1780									
erythropieura		1150-1600	1750-2100	1230-1650	1410-2100	980-2470	1610-1800	1770-2430	1140-2000	
gracilis			1750-1900	*	1775-2100	1700-2470	1790	2390-2740	1430-1940	
hectus	1780	1990								
ilitus	*	1580	1230							
jaemei		1150-1580								
johanneedeli						1600	*	1410-1540	1700	1500
juanchoi		1580	1750-2000	1600	1775	1800				
kelephus					1900-2250					
lasalleorum								3700-3850		
latilobatus	1780									
leoni	2600									
loustei	1200									
mantipus		1000	1750-2000	1580	2200-2400	1950	*	*	1500	
mars						1760-1790				
molybrignus		1600-2350	1100-1800	1230	1900	1180-1850				
myops					2100-2250	*	*	*	1500	
necerus	?									
ocellatus	1780	1050-1580								
orpacobates			1230-2000	1230-1590	1775	1180-1850	700	1400-1870	800-2000	1500
palmeni		1050-2200	1750-2100	1590	1775-2100	980-2470	1830-2200			
phalarus					2250					
platychilus		1580-2190	1750-2600	*	*	*	*	*	1900-2000	
polychrus					1490-1510	*	*	1410-1540	1140-1430	
ptochus					2100-2200					
quantus					2100-2250					
quinquagesimus	1780-2600									
restrepoi					1850-2250	1810-1880	1790	*	1960-2000	
ruedai					1850-1860	1500-1600	1610-1800	1410-1870	1000-1900	

Véase continuación en próxima página

Species	La Planada	Munchique	Farallones	Calima	Paraguas	Risaralda	Carmen	Urrao	Murri	Antadó
ruiizi			1900	1590						
sanguineus						950-1450	630-1030	820-950	800-1500	
satagus								3300-3850		
scolodiscus	1780									
signifer					1850-1860					
silverstonei			1900-2100	*	1900-2250					
siopelus	1780									
sulculus	1780									
thectopternus		1600-2520	1750-2100	1580-1600	2120-2200	1720-1800	2030-2200			
unistrigatus	3230									
verecundus	1780									
viridans		2000-2610	2600					1480-1870	1460-1960	1500
viridis										
w-nigrum	1780	1300-1800	1750-1900	1230	1410-2100	1500-2430	1610-2000	1400-2400	900-2000	1500
xestus					4050					
xylochobates					2100-2250					
Observed	22	25	24	12	32	21	9	21	23	7
Predicted	26	25	25	21	34	26	21	26		

Tabla 4. Distribuciones de las 26 especies de *Eleutherodactylus* en las tierras bajas del Pacífico colombiano en nueve transectos. En cada célula (especie por transecto), se encuentran los límites de altitudes de sitios. Una estrella se indica que no hay registros pero se presume que la especie está en este transecto.

Species	La Planada	Munchique	Farallones	Calima	Paraguas	Risaralda	Carmen	Urrao	Murri
achatinus	100-1780	100-1580	100-1200	10-200	80-950	90-1480	*	40-1060	420-1430
anomalus	100	100-800	10-1180	10-500	80-950	200-590	45-700	2-80	420
biporcatus		100	10-640	10-460	*	*	150	20-1060	805
bufoniformis		100	75-900	460	*	1200-1780	700	20-1060	805-950
caprifer	*	100-200	300-1230	460-940					
caryophyllaceus								50-1060	805
chalceus	1780	100-1580	300-1230	10-460	940-960	900-1480	700-1790	50-1870	1000-1900
fitzingeri				300	10-30	10-370	200-590	45-700	2-1070
gaigei				500	10	*	200	*	*
gularis	400-600	100-200	10-80	10-500	10	*	*	50-1060	
hybotragus				300-920	10-460				
labiosus	1055	800	300	30-460	300-500				
latidiscus	650	100-800	720-920	10-460	10-950	590	*	2	805
longirostris	100-1360	100-200	10-300	10-940	80-960	90-1280	45	2-460	400-805
moro				10	*	*	*	*	*
omatissimus	?								
parvillus	650-1360								
Q					30	*	95	*	2-1070
raniformis		100	1-1230	10	80-1050	90-1510	630-700	40-1430	350-805
ridens				10	10-940	10-110	100-590	45	2-1060
rosadoi	*	200							
roseus				10-900	10-200	10-600	90-590	*	50
subsigillatus	*	100-200							
taeniatus					10	100	*	*	50-1070
T				80-640	10-500	10	95	45	950-1870
zygodactylus				300-1180	460-940	600-950	230-1490	420-1030	850-1060
Observed	8	13	19	20	14	14	10	17	15
Predicted	12	13	19	21	19	18	18	19	17

lands (below 1000 m) or uplands. Such species as *E. chalceus* initially posed considerable difficulty (ranging from sea level to nearly 2000 m) but even that species appears to be a lowland one that invades cloud forests (Lynch & Duellman, 1997).

The plan of collections initiated by Pedro M. Ruiz and me nearly 20 yr ago proposed a series of transects over the three cordilleras as a means of efficiently documenting the rich frog fauna (chiefly centrolenids and *Eleutherodactylus*) of the cloud forests of Colombia. We then-reasoned that the lowlands were sufficiently collected but that the cloud forests had scarcely been sampled. For the Cordillera Occidental, nine transects were identified and collected (1980-1995). A tenth transect remains planned and the only collection available for it was obtained by the late Marco Antonio Serna.

Ruiz et al. (1997) described five transects (Murri [approx. 6°45' N], Urrao [approx. 6 25' – 6 30' N], Carmen del Atrato [approx. 5°40' – 5°50' N], Risaralda [approx. 5°15' – 5°20' N], and Paraguas [approx. 4°50' – 4°55' N]). The remaining four are as follows:

Calima: municipios Yotoco, Restrepo, Darién, Buenaventura (Valle del Cauca). Beginning on the crest of the Cordillera Occidental at the Reserve Forestal de Yotoco (Km. 18, Buga-Loboguerrero), 1590 m and proceeding west along the Río Calima. The westernmost site is Bahía de Málaga. [Much of the distributional detail of this transect is reported in Lynch (1998)]. Ca 4° N. 10-1590 m.s.n.m.

Farallones: municipio de Cali, La Cumbre, Dagua, Buenaventura (Valle del Cauca). Beginning on the east face of the Farallones de Cali, crossing the crest of the cordillera and extending toward the Pacific coast along the old road from Cali to Buenaventura. [Much of the distributional detail of this transect is reported in Lynch (1998)]. Ca. 3°20' N – 3°40' N. 10-2700 m.s.n.m.

Munchique: municipio El Tambo (Cauca). Beginning on the crest of the Cordillera Occidental NNW of Uribe and at Cerro Munchique and proceeding west down the western flanks of the cordillera. Collecting below 1500 m has proven very difficult in recent years and the lower portion of the transect remains to be collected seriously. Ca. 2°30' N – 2°40' N. 1300-3200 m.s.n.m.

La Planada: municipios El Espino, Barbacoas, Ricuarte, Tumaco (Nariño). Western flanks of the the macizo de Pasto along the road to Tumaco. The most extensive collections come from the Reserva La Planada

and were reported by Lynch & Burrowes (1990). Other collections were made by PMR in 1982 and 1995. Ca. 1°05' N – 1°20' N. 650-3230 m.s.n.m.

The expected (see below) eleutherodactyline frog faunas of each transect (upland + lowland species) and the observed/ expected totals for the nine transects are as follows:

Murri	(23 + 17)	38/40
Urrao	(26 + 19)	38/45
Carmen	(21 + 18)	19/39
Risaralda	(26 + 18)	35/44
Paraguas	(34 + 19)	46/53
Calima	(21 + 21)	32/42
Farallones	(25 + 19)	43/44
Munchique	(25 + 13)	38/38
La Planada	(26 + 12)	30/38

These figures announce an eleutherodactyline fauna of unparalleled proportions and provide easy comparison with the data reported by Lynch & Duellman (1997) for the rich fauna of western Ecuador which represents the southern component of this chocoan fauna.

The distributions of 76 species of *Eleutherodactylus* found (or expected) in the cloud forests of western Colombia are summarized in Table 3. Each of the ten transects harbors between seven and 32 species of *Eleutherodactylus*. These data do not include any of the lowland species, which may be distributed to considerable altitudes (see Table 4). Nevertheless, these data demonstrate that *Eleutherodactylus* in the cloud forests in western Colombia depart from the general pattern reported by Duellman (1988). I think two of the transects are poorly collected. The Antadó transect remains to be thoroughly sampled and the data for seven species collected by the late Marco Antonio Serna at one site represent almost all the available data (some data are available for the adjacent lowlands). The Carmen del Atrato transect (nine species) appears incomplete as well (several expected species were not taken). Ignoring the Antadó records, there are 227 species-transect cells in Table 3 of which 83% have vouchers. The 38 "missing records" represent 19 species of which two (*E. boulengeri* and *E. platychilus*) account for 10 missing records (five each). Nine missing records occur on the Calima transect and twelve occur on the Carmen del Atrato transect.

Using the density of asterisks ("missing species"), the several transects can be evaluated for completeness.

Seven either lack missing species or lack only one to four species whereas two transects have "high" levels of missing species (Calima and Carmen del Atrato). For the Calima transect, it appears that the sampling efforts accumulated only 57% of the fauna (and see below) whereas the Camen del Atrato sample obtained only 43%. Most well-sampled transects harbor about 21-25 species but the Serranía de los Paraguas is exceptional (32 species + two species apparently missed by collectors) and part of its richness is explained by the high number of endemics found there (eight). No other transect has so many endemics (the apparent richness of La Planada is misleading because nearly all of the species also occur in Ecuador [only *E. siopelus* and *E. sulculus* are endemic to that transect]; twelve listed only for that transect also occur in Ecuador [Lynch & Duellman, 1997]). Twenty-three species are distributed south into Ecuador (Lynch & Duellman, 1997) whereas none of these species range north into Central America (unlike the lowlands fauna). The two northern transects have very limited use in calculating their own expected (predicted) faunae. For the remaining eight transects, the expected faunas range from 21 to 34 species with documentation (voucher) values of 43-100% (mean 80%). Three transects appear very well sampled (Paraguas, Farallones, and Munchique).

Under the reasonable assumption that distributional areas ought to be contiguous if the habitat is available, our initial surveys have missed only 38 records (asterisks in Table 3). Some of these no doubt reflect our failure to sample higher on the transect (Calima, where we sampled only to 1590 m) whereas others reflect the rarity of particular species (*E. babax*, *E. cerastes*, and *E. platychilus* are seldom common animals and hence relatively easily overlooked or missed during brief inventory visits). Yet another explanation for missing records would be distributional discontinuities but to date there is little evidence of these for the Cordillera Occidental (although some of these species apparently have distributional disjuncts on the Cordillera Central [Ruiz-C. et al., 1996, 1997]). I have no idea of how complete the distributional ranges might be (the absence of a record on the transect to the north or south might reflect only the edge of a species' distribution). In only a few cases is there some evidence from systematics that lends support to the idea that the edge is real (i.e., the presence of a sister species in the adjacent transect [Lynch, 1992; Lynch & Ruiz, 1996]). Nineteen species (26%, which might appear high or low) are known from single transects. In the cases of *E. lasalleorum*, *E. satagus*, and *E. xestus*, species from high altitudes, this probably merely reflects the geographic fragmentation of páramo habitats in the Cordillera Occi-

dental whereas in the cases of *E. albericoi*, *E. diaphonus*, and *E. diogenes* as well as *E. cacao*, *E. jaimei*, and *E. mars*, it may reflect very local distributions among species of particular *Rassendkreisen* and the expected consequences of vicariant speciation (Lynch, 1989), and in the case of the eight endemics on the Serranía de los Paraguas, some sort of center of speciation.

The Pacific lowlands of Colombia (biogeographic chocó) are more famous as a center of biodiversity (reflecting the avian and/or lowlands biases of most biologists) and harbor a rich eleutherodactyline frog fauna (Table 4). Its eleutherodactyline fauna has been the subject of two now-dated analyses (Lynch, 1980; Lynch & Myers, 1983). Of the 26 species known (or expected) in the biogeographic chocó of Colombia, none is restricted to a single transect in contrast to the situation on the western slopes. Such an observation suggests that collecting has been adequate to sample the lowland fauna and also suggests that species from the lowlands tend to have larger distributions than do species from the cloud forests (Peters, 1973). Nevertheless, some lowlands species (*E. hybotragus*, perhaps *E. roseus*) are notable for their small distribution areas and contrast sharply with the distributions of a few highland species (*E. babax*, *E. cerastes*, *E. erythroleura*, *E. w-nigrum*).

Of the 26 species known or expected in the lowlands of western Colombia, two (*E. achatinus*, *E. longirostris*) are wide-ranging (Panama to Ecuador) whereas ten (*E. biporcatus*, *bufoniformis*, *caryophyllaceus*, *fitzingeri*, *gaigei*, *moro*, *Q.*, *raniformis*, *ridens*, and *taeniatus*) occur in Colombia and lower Central America (at least Panama, a few as far north as eastern Honduras). Six of these "Central American" taxa occur as far south only as Valle del Cauca whereas three are known into western Cauca. Ten other species (*E. anomalus*, *caprifer*, *chalceus*, *gularis*, *labiosus*, *latidiscus*, *ornatissimus*, *parvillus*, *rosadoi*, and *subsigillatus*) are species of Colombia and Ecuador. Their northern limits are varied (two into Nariño, two others into Cauca, two others to the Rio San Juan, and four into the northern part of the Colombian Chocó). Only four species (*E. hybotragus*, *roseus*, *T.*, and *zygodactylus*) are endemic but their distributional limits correspond with others mentioned above (Valle del Cauca and the northern part of the Colombia Chocó).

These ranges of distributions over the nine transects generate 155 species-transect cells (Table 4) for which 130 (84%) have vouchers. The "missing species" (25 cells for 15 different species) include eight for one transect (Carmen del Atrato) and nine shared by the two transects to the south. Two generally rare species (*E. gaigei* and *E. moro*) account for nine missing species cells. The richest

and best studied transect (Calima) even has one missing species. The nine transects have between 56 and 100% of their expected eleutherodactyline faunas as vouchers.

These two data sets (lowlands and cloud forests) are comparable in terms of the efficiency of sampling, which, frankly, was initially a surprise to me. My colleagues, María Cristina Ardila and Pedro M. Ruiz, and I have spent relatively little time in the western lowlands of Colombia whereas we have devoted many enjoyable nights documenting the diversity of frogs in the cloud forests. However, the western lowlands have been collected by many biologists over the past century whereas the cloud forests have only recently come under close scrutiny.

Acknowledgments

Access to collections was provided with every courtesy by Fernando Castro, William E. Duellman, W. Ronald Heyer, Arnold Kluge, Charles W. Myers, Ronn Nussbaum, the late Hmo. Marco Antonio Serna, Harold Voris, Ernest E. Williams, John Wright, and Hmo. Luis Zamudio. For assistance and companionship in the field, I thank María Cristina Ardila, Umberto Carvajal, Fernando Castro, Taran (Pedro) Grant, Paul Gutiérrez, Jorge Restrepo, Pedro M. Ruiz, Ricardo Sánchez, and Erik Wild. Lastly, I thank Kraig Adler and the late Charles F. Walker for firing my interests in the eleutherodactyline fauna of western Colombia by inviting me to study Adler's 1965 collections.

Literature cited

- Cochran, D. M. & C. J. Goin.** 1970. Frogs of Colombia. U. S. National Museum, Bull. (288):1-655.
- Duellman, W. E.** 1988. Patterns of species diversity in anuran amphibians in the American tropics. Ann. Missouri Bot. Gard. **75**:79-104.
- Kattan, G.** 1984. Ranas del Valle del Cauca. Crespedesia **13** (49-50):317-341.
- Lynch, J. D.** 1980. Systematic status and distribution of some poorly known frogs of the genus *Eleutherodactylus* from the choocoan lowlands of South America. Herpetologica **36**:175-189.
- _____. 1981. Two new species of *Eleutherodactylus* from western Colombia (Amphibia : Anura : Leptodactylidae). Occas. Pap. Mus. Zool. Univ. Michigan (697):1-12.
- _____. 1989. The gauge of speciation: On the frequencies of modes of speciation, pp. 527-553, In : D. Otte & J. A. Endler (eds.), Speciation and Its Consequences. Sinauer Assoc., Inc.
- _____. 1992. Two new species of *Eleutherodactylus* from southwestern Colombia and the proposal of a new species group (Amphibia : Leptodactylidae). J. Herpetol. **26**:53-59.
- _____. 1993 [1992]. Distribution and variation in a Colombian frog, *Eleutherodactylus erythropleura* (Amphibia : Leptodactylidae). Stud. Neotropical Fauna Environ. **27**:211-226.
- _____. 1996. New frogs of the genus *Eleutherodactylus* (family Leptodactylidae) from the San Antonio region of the Cordillera Occidental. Rev. Acad. Colombiana de Ciencias Exactas, Físicas y Naturales **20** (77):331-345.
- _____. 1998. Lista anotada y clave para las ranas del género *Eleutherodactylus* de las tierras bajas del occidente del Valle del Cauca, Colombia, con apuntes de las especies de la Cordillera Occidental adyacente. Caldasia
- & **M. C. Ardila-Robayo.** 1993. *Eleutherodactylus zygodactylus*. Cat. Amer. Amph. Rep. (560):1-2.
- & **P. A. Burrowes.** 1990. The frogs of the genus *Eleutherodactylus* at the La Planada Reserve in southwestern Colombia with descriptions of eight new species. Occ. Pap. Mus. Nat. Hist. Univ. Kansas (136):1-31.
- & **W. E. Duellman.** 1997. Frogs of the genus *Eleutherodactylus* (Leptodactylidae) in western Ecuador: systematics, ecology, and biogeography. Nat. Hist. Mus., Univ. Kansas, Spec. Publ. **23**:1-236.
- & **C. W. Myers.** 1983. Frogs of the *fitzingeri* group of *Eleutherodactylus* in eastern Panama and chococoan South America (Leptodactylidae). Bull. Amer. Mus. Nat. Hist. **175**: 481-572.
- & **J. V. Rueda-Almonacid.** 1997. Three new species of frogs (*Eleutherodactylus*) from cloud forests in eastern Departamento de Caldas. Rev. Acad. Colombiana de Ciencias Exactas, Físicas y Naturales **21** (79):131-142.
- Lynch, J. D., P. M. Ruiz-Carranza, & M. C. Ardila-Robayo.** 1994. The identities of the Colombian frogs confused with *Eleutherodactylus latidiscus*. Occas. Pap. Nat. Hist. Mus. Univ. Kansas **170**: 1-42.
- , , , . 1997. Biogeographic patterns of Colombian frogs and toads. Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales **21** (80):237-248.
- Peters, J. A.** 1973. The toad genus *Atelopus* in Ecuador. Smithsonian Contrib. Zool. (145):1-49.
- Ruiz-Carranza, P. M., M. C. Ardila-Robayo, & J. D. Lynch.** 1996. Lista actualizada de la fauna de Amphibia de Colombia. Rev. Acad. Colombiana de Ciencias Exactas, Físicas y Naturales **20** (77):365-415.
- Ruiz-Carranza, P. M., J. D. Lynch, & M. C. Ardila-Robayo.** 1997. Seis nuevas especies de *Eleutherodactylus* Dumeril & Bibron, 1841 (Amphibia: Leptodactylidae) del norte de la Cordillera Occidental de Colombia. Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales **21** (79):155-174.